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OCTOBER 2007

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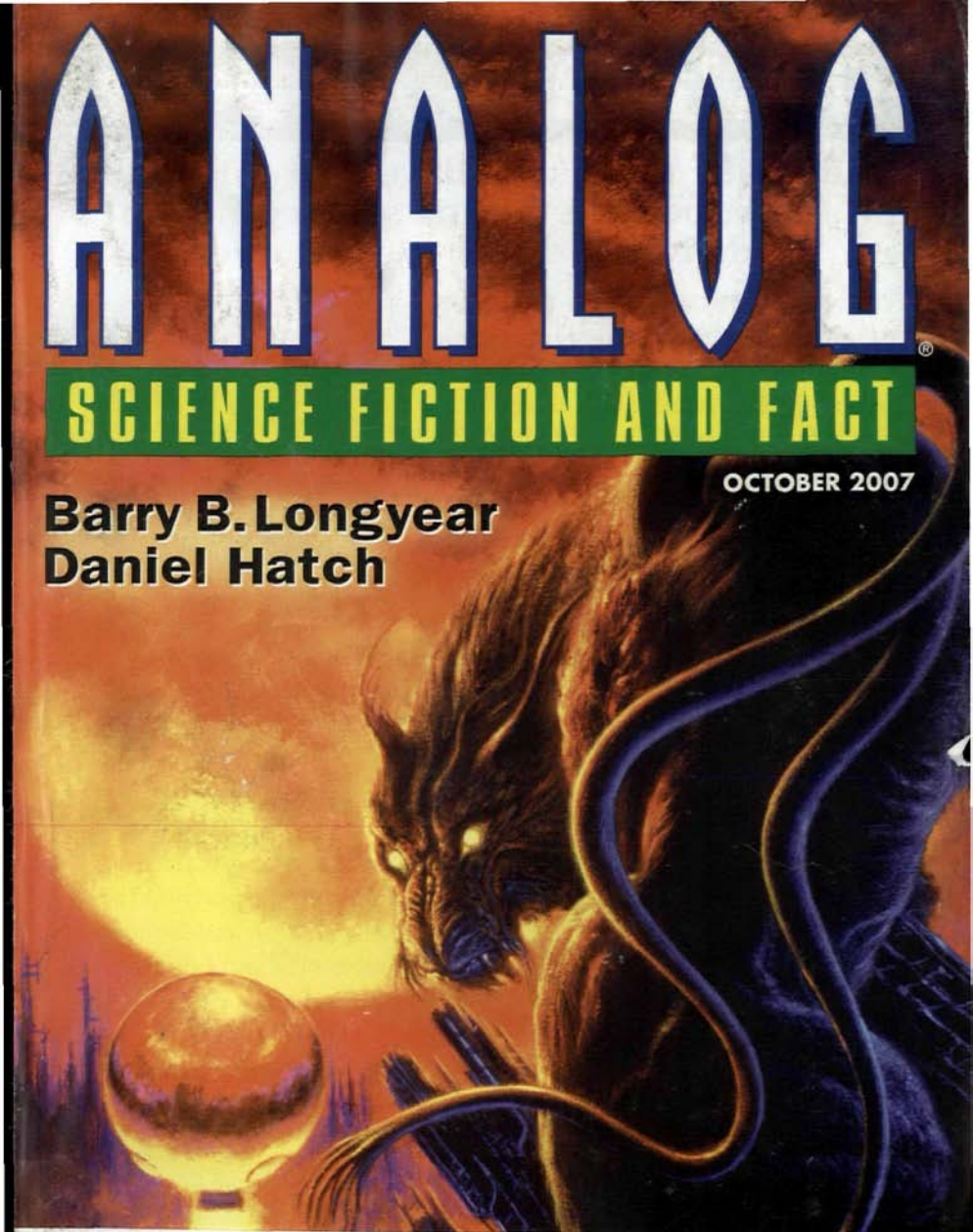

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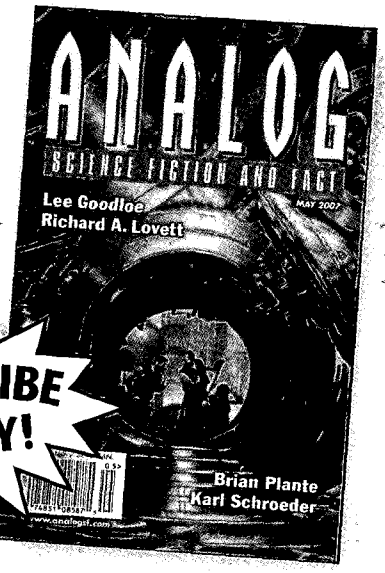

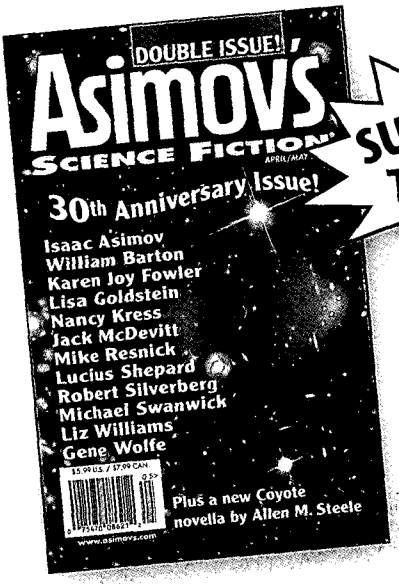

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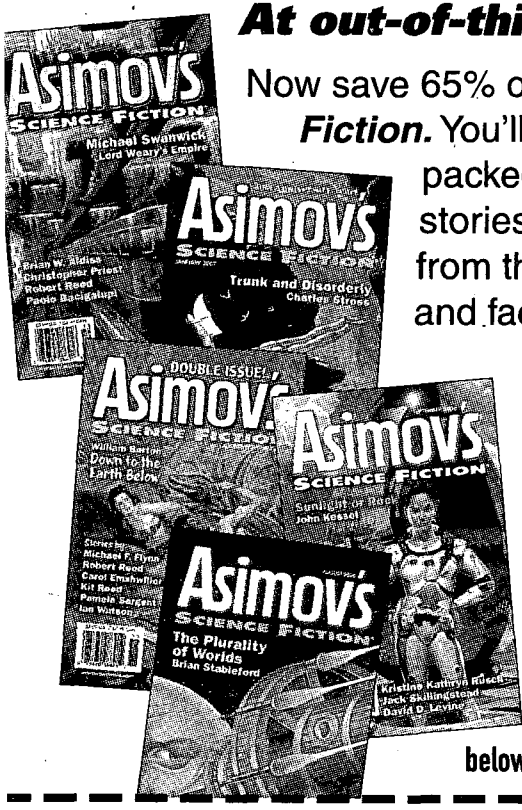

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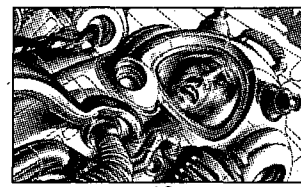

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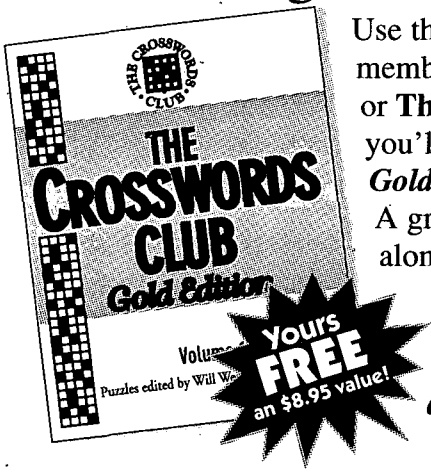

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GESTURES

"When I make a joke," Will Rogers said, "it doesn't harm anyone; you can take it or leave it. But when Congress makes a joke, it's a law."

You may have heard it in a slightly different form, and they may all be true; he made lots of speaking appearances and probably varied the details from time to time. But the essence of it is the same, and it contains an uncomfortable nugget of truth: when Congress—or any governing body—does something foolish and calls it legislation, it has real consequences for real people, and they may not be funny. And legislation is, after all, what governing bodies do.

Right?

Well, at least some of the time. (Some might say too much of the time. Remember Robert Heinlein's suggestion of a bicameral legislature with one house to make laws and another to repeal them?) Lately, it seems, we've been having an epidemic of such bodies spending their time and taxpayers' dollars making proclamations that may or may not be jokes, but are expressly presented as *not* being laws.

Consider two recent examples at very different levels of government. I'm writing this in March, at a time when the newly Democratic-led Congress is playing with "nonbinding resolutions" expressing disapproval for the president's latest plan for dealing with the war in Iraq. And several local school boards have promulgated "bans" or "moratoriums" on "the N-word" or the currently fashionable teen slang phrase "That's so gay," even though they say quite openly that they aren't *really* bans because they won't be enforced.

So what, if anything, is the value of such actions?

To answer that, I think, we have to consider what these groups are *really* doing, which may or may not be what they say they are doing. The simplest case is to suppose that they are actually doing what they say: making a symbolic statement (to borrow the term used by a representative of one of those school boards) of what they consider a moral position, without trying to compel anybody to agree with it or act on it. In principle, there's nothing wrong with that. We all express opinions without demanding that anybody accept them; I do it all the time, right here in these pages. But to what extent is it a worthwhile or desirable thing for a legislative body or a school board to do?

Bear in mind that we are paying these people to produce particular kinds of results. In the real world, merely saying what they would like to happen will seldom ensure that it will happen. To ensure actual effects, they need to lay down specific requirements for what people will do, and impose—really, not just on paper—penalties for noncompliance. For example, if Congress really expects to block a president's policies (on anything) they must do things like cutting off funding to carry them out. If a school board really wants to make sure nobody says the N-word, it will have to

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ban it and punish those who say it anyway. Those are such drastic steps, with such foreseeable repercussions, that they're understandably reluctant to take them.

But if they don't, it's awfully tempting to see such "nonbinding" or "symbolic" gestures as empty and meaningless, wasting time and money that they're employed to use more productively. (Though again, as Will Rogers hinted in my opening quote and others have also suggested in cynical moments, that's not necessarily such a bad thing. After all, if they're not really doing anything, at least they're not hurting anything. I'm reminded of Clarence, the sidekick of Mark Twain's *Connecticut Yankee in King Arthur's Court*, who made a surprisingly persuasive case for why a cat might be a better king than a man. . . .)

But let's consider another option that may be more likely: that those who put forth symbolic or nonbinding resolutions are being disingenuous and actually have more than that up their sleeves. This possibility, too, breaks down into a couple of likely cases. Both Congress and those school boards have indicated that although they are not making laws with teeth, they are hoping to influence people's behavior. At least one of the education people has said they hope their "moratorium" will get people to thinking more about their heretofore casual use of offensive words or phrases, and as a result to use them less. Congress (or rather, the current majority of its members which has so voted) has indicated that it hopes to nudge the president to rethink his policies by making explicit that he no longer has their overwhelming support. In each case, if we take them at their word, we are still to believe that they are really not trying to *force* anybody to do anything, but simply hope that gentle persuasion will lead others to straighten up and fly right. (Or, more precisely, what those attempting the persuasion see as right, which is not necessarily the same thing, no matter how popular or unpopular their views may be).

If that is the case, I still wonder whether it's a worthwhile use of their time and energy. Or should I, as a taxpayer (and one of their employers) expect something a bit more likely to produce tangible results?

If so, maybe I needn't worry, because maybe what's really going on is the last possibility I hinted at: that the "nonbinding" and "symbolic" acts are merely trial balloons, preliminary feeling out of public or official opinion as a prelude to similar acts that do have teeth. Maybe the idea is that making such gestures will (a) give people a face-saving opportunity to do "voluntarily" what the resolvers would like them to do, and (b) pave the way for the use of force if they fail to do so. In the deviously wonderful world of Washington, I can well imagine that this is the case; and I suspect that the same

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principle, if on a smaller scale, applies to local school boards as well. So maybe in some, if not all, of these cases, the folks making nonbinding and symbolic resolutions do intend to make things happen, and see what they've done so far only as a first step.

If so, is their approach a subtle and commendable use of diplomatic skills to do something that needs to be done, but would be hard to directly and in one swell foop? Or is it a stealthy and insidious step toward something that shouldn't be done at all?

The answer, of course, depends on whom you ask, and on what ends they would consider desirable. And if you conduct a survey, you'd do well to weigh the answers carefully, bearing in mind that a great many people find it easy to shrug off one principle they claim to believe in if it gets in the way of another about which they care even more.

Consider, for example, the congressional resolutions scolding the president for his Iraq policies. (And please bear in mind that since many relevant developments will probably have happened by the time you read this, this is *not* about those policies, but about the kinds of processes currently being used in the effort to modify them, which are also used in many other contexts). Many citizens, including a majority of the recently reconstituted Congress, sincerely believe that the president's policies have so far taken the country too far down a dangerous path, and we need to get onto a new course with all possible haste. The president, and a significant number of other citizens, believes just as sincerely that it's necessary to finish what's been started, and that going along with the current congressional motions would be the disastrous course. Those in the first camp are likely to applaud anything Congress can do to get things to come out their way; those in the second will understandably do anything they can to prevent that.

This is as it should be—up to a point. The legislative and executive branches *should* argue, frequently. That forces both of them to consider other points of view and come to compromises, instead of either getting its way too easily (as can happen when too much of the government is controlled by a single party [*any* single party]). But both of them, at least in this country, need to keep in mind during all such arguments—and

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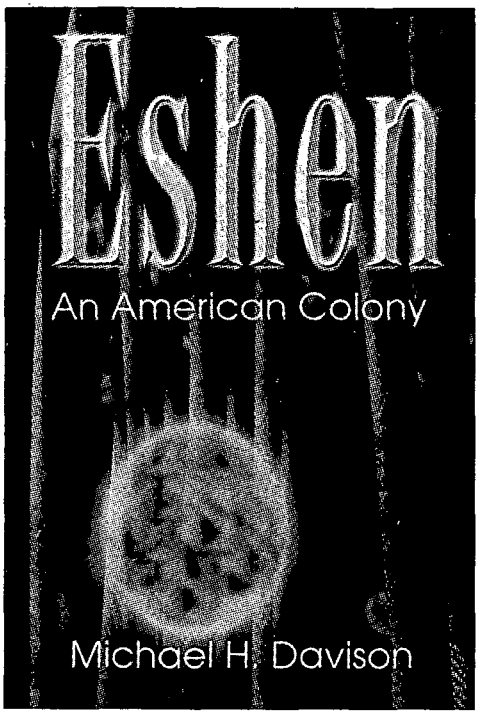

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be forcibly reminded, if and when necessary—that there are limitations on what kinds of tactics are acceptable, and that those that go beyond the limits (many of them conveniently gathered in the Constitution) won't be tolerated.

The case is perhaps a bit clearer, and not quite as inflammatory, in the case of the school board resolutions. After all, a great many of us, perhaps even an overwhelming majority, find some terms of "hate language" extremely offensive. Surely no governing body in this country would go on record as endorsing their use—but does that mean any such body should even pretend to ban them? To me, that seems a dangerous precedent to set, because banning a word—really banning it, and enforcing the ban—would be a clear and flagrant violation of one of the most basic freedoms guaranteed by our constitution: the freedom of speech.

But that doesn't mean it can't happen. Everybody talks about the virtues of freedom, and we all want it for ourselves. But frighteningly few of us are willing to take the next step and recognize, deep down, that freedom only means anything if it applies equally to ourselves and to others—even others with whom we disagree as strongly as possible. And many of us are quite adept at rationalizing exceptions to basic freedoms—for other people. Another much-publicized case near the time of my writing this involved students who, in an "open mike" session at a high school, uttered "the V-word" in a reading after having allegedly promised not to, and were punished with suspension (later rescinded after heated public controversy). School officials defended their suspension by saying it wasn't about censorship, but only about insubordination and breaking a promise, but that's a

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transparent smoke screen. The students denied making the promise, but whether they did or not, censorship clearly *is* the central issue here. If administrators even asked them to make such a promise, that request is as clear an act of censorship as I can imagine.

So when I hear groups in power making nonbinding or symbolic gestures that would be censorship or otherwise illegal or immoral if they were enforced, I have to wonder: what's next? Will they attempt a binding one if public reaction to the "symbolic" gesture suggests they could get away with it? In the particular case I just mentioned, they didn't get away with it; I suspect public reaction made the administrators feel as if they had their feet painfully far down their gullets. But I can't assume it would always be so.

Certainly at least some members of Congress have made it clear that they will try to enact enforceable laws if they don't get their way by other means. I respectfully suggest that when *any* powerful body puts forth a nonbinding or symbolic statement about what others should do, we should examine it critically in the light of this question: what if they did enforce it? If it's not something we'd be willing to have enforced, it probably shouldn't be enacted at all.

And in any case, their time would be better spent doing what we hired them for: making real laws that we need (and repealing ones that we don't). ■

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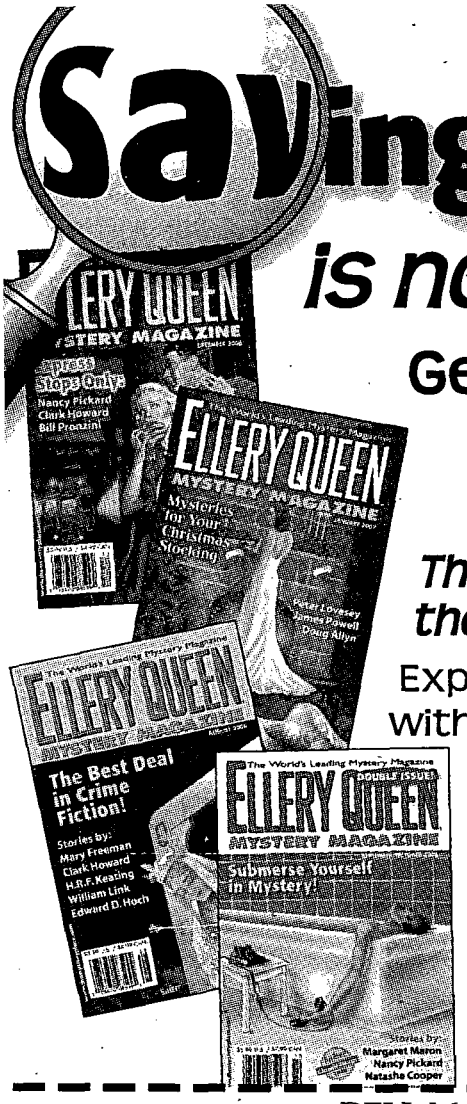

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An Angelheaded Hipster Escapes

Daniel Hatch

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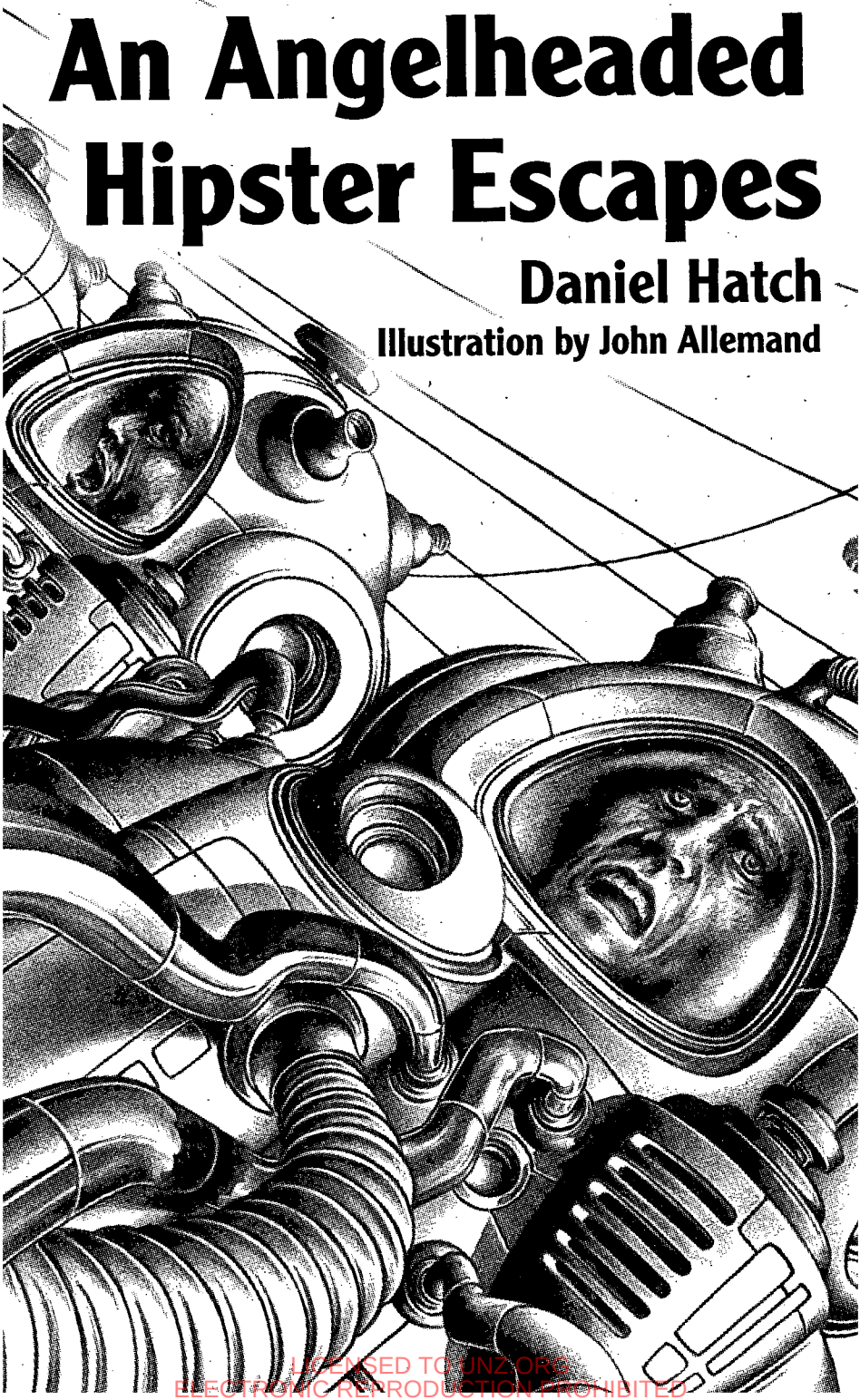

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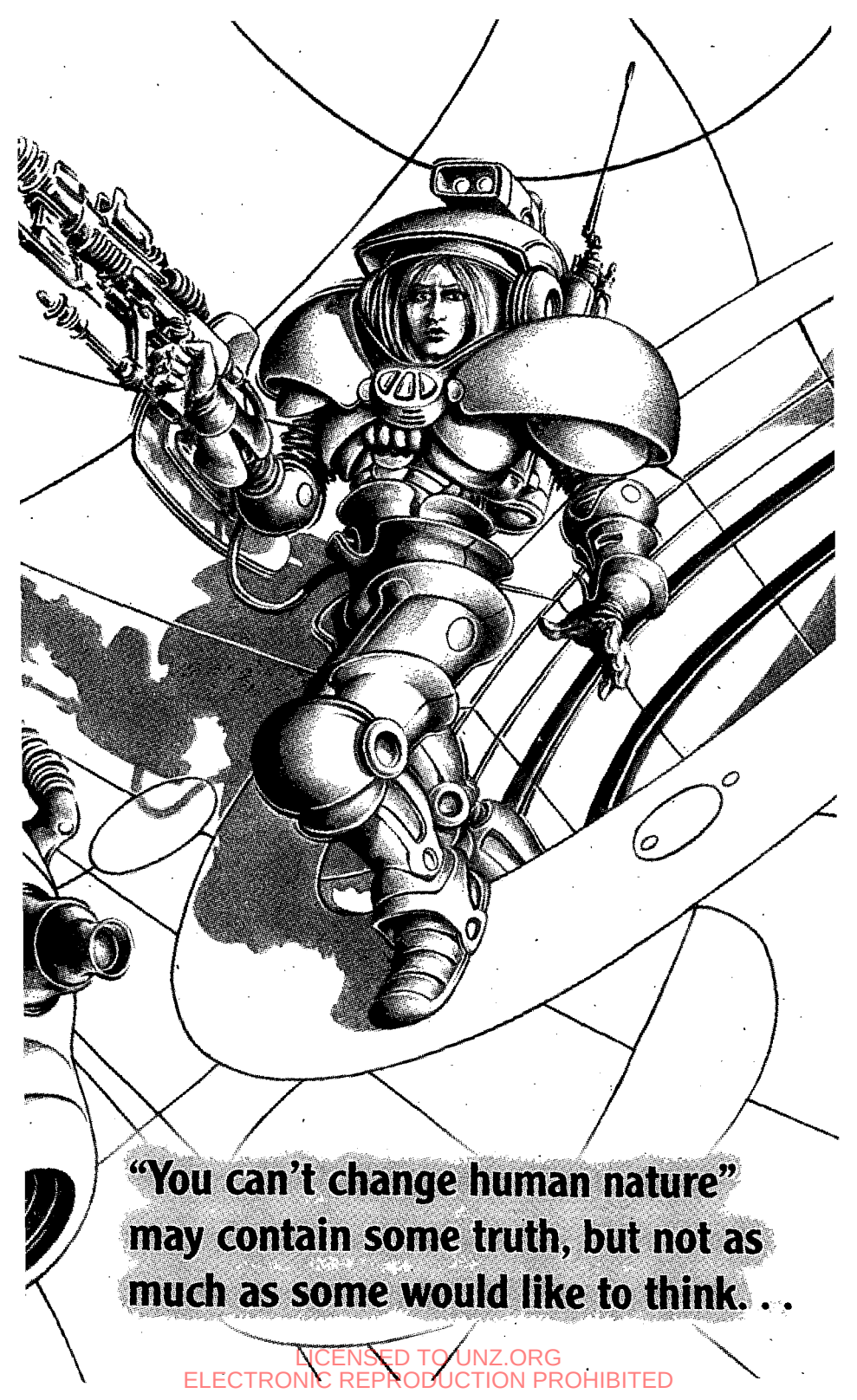

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Four of us were working at the New Palomar L-1 Solar Observatory on the day of the rescue—Roger, Anne Marie, Torazel, and me.

Roger was a burnout. He had his head wired so completely into the machinery, his endorphins and neuroreceptors plugged so directly into the I/O bus, his memory so totally off site, that he had become little more than one more module on the network. He had become what they wanted us all to become.

But not completely. When you talked to him—and he responded—he was the same old Roger. Rude, self-centered, insulting, and arrogant. Once a jerk, always a jerk, no matter how much of it is plugged in. He'd been a soldier. And a bigot.

"You know what we called people without implants?" he asked for the thousandth time since I'd arrived at the lab. "'Mud people.' They were stuck in the mud. Leftovers from the past. People without a future."

"You know, they always wanted special treatment while the rest of us didn't get jack," he said. "Always whining about how unfair the world is, while guys like you and me were making history, doing the hard work, making the future."

It wasn't a discussion I ever wanted to pursue, but he was my only social contact for thousands of kilometers. I tried to put up with it. The worst of it was the boredom it inspired by repetition.

On this day, however, with the first indication that great events were about to transpire, he interrupted his screed and was all business.

"What's that noise at the edge of the corona?" he asked suddenly.

I turned my attention to the array of solar monitors. At first, there seemed to be a large explosion of mass and energy on the limb of the sun, but the configuration was all wrong for a coronal discharge. I checked the visuals from one of the telescopes and saw that the boundaries of the event were expanding at a terrific rate—approaching relativistic speeds, if the figures were correct.

"It's anomalous," I said. "But I'm dumping all the data to a hard file if you want to review it."

The machines were clicking away, but none of them had anything to say out loud. They were awful at integrating real-time events, so I didn't expect them to. That was what they had Roger and me and the others for.

Torazel made some odd noises, but nothing that could be considered an attempt to communicate. She used to be a dancer. She had given it up long ago, when she thought all she had was arthritis. It turned out to be bone cancer. She was another burnout, but not like Roger. She had cross-scripted her inputs and could produce endorphins on command. The command came whenever she felt something—anything. We kept her off the network as much as possible. She was damaged goods long before she got to L-1. The machines had been ripped off by a clever salesman. All right, he probably didn't have to be too clever to rip off the machines.

"This data doesn't make much sense," Roger said. "Are you sure the monitors are working right? Did you calibrate them properly? Are you dumping the data multichannel or broadband?"

"The data's right," I said. Then an idea struck me:

And that was really what the machines had us around for.

Ideas never struck them. Without us, they'd just click along until protons decayed, collecting data without knowing why, without understanding what it was, without pursuing the interesting, the unusual, the anomalous—the profitable.

My idea was that in order for the data to make sense, the event couldn't be taking place on the surface of the Sun. It had to be much closer. And the closer it was, the less mass was being pushed around, the smaller the energies involved could be, the more compact and

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immediate the phenomenon could be.

"It's close," I said. "Real close."

"I see that now," Roger said. "Plasma gases, just like a coronal discharge. But if you correlate temperatures and velocity, it's only a matter of a few thousand kilometers."

"Wrong," I said with sudden satisfaction. "It's only a matter of a few kilometers. That's no coronal discharge. That's a spacecraft."

The machines didn't skip a beat once they realized I was right. Alarms went off—right down to the old audible general quarters clangors that rattled the airless steel boxes that made up much of the L-1 station.

"Incoming spacecraft!" Boss No. 5 flashed in all his frames up and down the network.

"Prepare for hostile action!" Boss No. 2 commanded.

The bosses didn't have much of a face. Out here where the tides cancel out, you didn't get many visitors. No humans to speak of. Or interface with. Most machines could muster up a halfway decent interface designed to fool you into thinking you were talking to real person for at least two or three minutes. But New Palomar was a small-cap nonprofit that relied on grants and endowments for revenue, so all it needed was a grant-writer face and a research product that met the standards.

Ann Marie began to cry softly. Ann Marie had good days and bad days. On the good days, she could remember a lot of things—where she was, who we were, what she was doing here. This wasn't one of her good days.

They were coming at us out of the Sun. That was a bold tactic, considering that we were a solar observatory. But they were all stealthed up, and the flood of photons, protons, and other particles and energies pouring over us from the center of the solar system kept us from spotting them until they were on top of us.

"Arrrrrrrghh!" Roger growled as the attack craft blasted away at us with high-energy information beams. All at once the proximity radars, tracking radars, radio antennas, lasercomm transmitters, and defense systems were seized by malware and shut down.

"Defensive perimeter breached!" flashed Boss No. 5 from behind his firewall.

"All subsystems prepare for internal boarders!" flashed Boss No. 2, desperately warding off spybots.

On one wall of the lab, an aluminum shield folded back to reveal a gimbaled mount half a meter in diameter with a weapons-grade laser and a magrail projectile launcher. Roger was probably at work behind the controls, ready for action, ready for danger.

But that wasn't what I wanted Roger to do.

Because I knew who the attackers were. And I knew why they were here. They were here because I'd invited them.

And they were here for me.

"Hey, Roger," I flashed. "Look up there! It's Halley's Comet!"

Roger was slow to integrate. He had to decode my nontech language, then he had to determine its real-time meaning, then he had to reject that meaning as nonsensical, then he had to wonder why I was making nonsense remarks in real time. And by then, I'd slipped in and taken over control of the weapons mount on the wall.

"You son of a bitch!" he yelled. "Give that back to me."

"Not today," I said. "You might get carried away and hurt someone."

I energized a local VHF transmitter outside the lab and sent out a call on the FM band. "We're in the lab," I said, describing the location as clearly as I could.

Ann Marie continued to cry. Torazel continued to present a flat line output, with all neuroreceptors plugged. And Roger seemed to have found access to some deep library of profanity and was

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directing it toward me.

I barely had time to savor the immense relief of watching the door smash open to reveal a boarder with two arms, two legs, and a head, all encased in a suit of mirror-bright power armor, when Roger made his move.

He tried to use brute force. He got into the environmental controls and tried to shut off my oxygen. Tried, but ultimately failed. My kit was too self-contained for that.

Maybe his hope was to distract me long enough to regain control of the gun mount. But I never gave him the chance. I lit off a few rounds from the projectile launcher. They hit the wall beside me, so I tracked to the left. Roger never knew what hit him. Or rather, what hit the junction box where all his lines plugged into the station. I couldn't actually bring myself to kill him, but I wasn't going to let him interfere with my plans.

"I'm sorry I had to do that," I said to no one in particular.

The boarder was suddenly all alert, feet fastened to one of the walls, weapon at the ready. A visor snapped up, and I got a look at a face. The boarder was a woman.

"Jonathon Bender?" a sweet voice asked over the VHF-FM. She sounded like an angel, and I was suddenly in love. I probably would have felt the same if she were a hundred-kilo male spacetrooper.

"Over here," I said. "I'm over at the first work station to the south of the big window. You can't miss me."

Through the door I could see a security bot scrambling to get its footing in the passageway. I swung the gun mount around, which seemed to upset the woman in the space armor. She made a quick bound into the compartment, spinning about as she glided through the microgravity.

"Watch out!" I called. I let off a few rounds at the security bot and drew some satisfaction from the sight of its head shattering into a million pieces, which scattered around the lab in pure ballistic trajectories with lots of ricochets.

Then my rescuer fired her own weapon at a second bot just coming into the doorway and fried his circuits with a laser bolt.

"I think that one was aiming at you," she said.

"The machines must have realized that I'm the source of their troubles," I said. "Look, I'm over here in the orange can. The one with the tubes and wires. Don't worry; there are no booby traps. Just uncouple the tubes and unjack the cables. I'm completely self-contained."

She pulled herself along hesitantly toward me, then quickly broke all the connections. We flew across the compartment for the door.

"Wait a minute," I said as she pulled me roughly along. "What about Ann Marie? I know she's got Alzheimer's, but somewhere in there is a living human being. You can reverse the damage. The memories are still locked up in there. I know you can do it. I've seen it done. And Torazel. She can be salvaged too."

I felt guilty about not asking for help for Roger. But it didn't matter because nothing I said seemed to affect the woman in the space armor. We didn't turn around and go back. I realized that I was probably fooling myself. Ann Marie was just as far gone as Torazel. Or Roger, for that matter. There was nothing I could do for them. I had to look out for myself now.

A moment later, we were heading weightless down the passageway to the hole where the spacecraft had forcibly docked with the observatory. Ragged pieces of foil and the bitter ends of wires and cable had burst inward and littered the hall.

Then we were inside the other spacecraft. Lots more boarders in space armor packed into a tiny space, removing helmets to reveal heads that seemed too small for the bulky suits. We passed them all by and entered a slightly less tiny space with no occupants but me

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and my rescuer, who backed up against a maintenance bay and cracked open the armor.

What emerged was a vision from ages past, when I was young and alive and had all my hormones. Her long auburn hair flowed down over mocha-colored skin, lots of skin and nothing else. Long, long ago, in another century, in another entire form of existence, I'd been happily married for decades. But the sight of this woman made me forget all about that. The human form, the artists say, is the source of all beauty. Even without all the hormones, I was enthralled. It had been a long time since I'd been this close to that much beauty.

She reached into a mesh sack tethered to the wall and pulled out a lime green coverall. When she was done twisting into her clothes, she turned her attention to me.

"Are you still there?" she asked. Her accent was pure music—English with broad misshapen vowels.

"I certainly am," I answered.

She pulled back suddenly at the sound of my voice. The fidelity was much better.

"I am Penelope Antoinette de Sandino y Murphy," she said. Her name only suggested the origins of her accent. More sounds were at work there than just the obvious Latin American notes.

"And I am Jonathon Bender," I said. "Born 1951 in New London, Connecticut, graduate of Wesleyan University, master's at the University of Arizona, doctorate at Oxford. Married once, two kids, seven dogs, lots of cats, a bird. Spent a long career staying up all night and turning beautiful visions of the heavens into boring rows of numbers. A genuine messenger from the historic past. Witness to Watergate, Vietnam, both Bushes, both Clintons, and the melting of the ice caps. At your service."

"So you really are the Bender Relic," she said. "Good. No mistakes. I like that."

She smiled, then grabbed my containment by the handles. The room seemed to swivel around several axes simultaneously as she swung me up and into a recessed compartment.

"Hey! Don't do that! Stop!"

She didn't stop.

"And I think you have a very nice face."

It was the last thing I heard her say as she flipped the door closed. She left me alone in the dark with nothing but my own thoughts. A very nice face indeed. That was no interface, that was me.

Did she really think I was just another machine?

What an insult.

What an outrage.

What a disaster.

To sleep. Perchance to dream. I was running through the Arizona desert with seven-league boots, zigzagging among the cactus, bounding off the hilltops in great leaps. And keeping pace at my side was Penelope Antoinette de Sandino y Murphy. She didn't say a word. She just smiled.

We were heading up Mount Lemon when the phone rang.

I switched on my eyes, but all I saw was the dim glow of tattletale lights on my containment, reflecting off the inside of the compartment that held me. The phone kept ringing. I answered it.

"Yeah," I said, still not quite awake.

"Mr. Bender?" asked a male voice.

"That's me."

"I'm Jim Raffel. I'm the face of the spacecraft that's carrying you back Earthside. How are you doing this watch, partner?"

"How do you think I am? Someone stuffed me in a storage bin and left me in the dark."

Jim paused for a moment, then continued. "The storage bin is the safest place we could find for you in case we have to do some sharp maneuvering."

"Thanks . . . I think."

"I've been looking over your interface. You've got a pretty odd firewall. She's

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impossible to penetrate, and I couldn't find any security entries."

"That's not a firewall. That's me."

"I'm not sure I understand you, partner."

"And I'm not sure I want you poking around inside my kit."

"It's just a simple safety inspection, partner. Nothing invasive. Now I wonder if you could help us out. I have a few questions I'd like to ask you."

"Shoot."

"What day is today?"

"Friday."

"What is your favorite food?"

"Buffalo wings with blue cheese dressing."

"Who do you prefer, Monet or Manet?"

"All right, that's enough. I know what you're doing. This is a freaking Turing test." I noticed the volume in my voice rising. "Well, you can tell Penelope Antoinette de Etcetera that I don't take Turing tests—I design Turing tests. End of conversation."

Then I hung up on him.

I was beginning to have serious doubts about my new benefactors.

I could tell they had nerve because they charged right into the L-1 solar observatory with guns blazing. But they didn't seem to match that with brains. Maybe that was why they came for me.

The phone rang again. I let it go for a while, then picked it up.

"Mr. Bender, I owe you an apology."

"You've got that much right."

"Ms. Sandino is kind of young—compared to us anyway. Her instructions were clear, but inappropriate. Can we start over again?"

"Is she monitoring this call?"

"No way, partner. She's busy on the bridge."

I wondered what there was to be busy about on the bridge during the transit to Earth. On a low-energy transfer ellipse, it's a three-day trip, with gravity doing all the work. I filed the question away for later.

"Start over how?"

"I'll act like you are a human being, and you can act like a human being."

I laughed—it probably sounded like static to Jim—and he didn't. As an interface, he really didn't have a sense of humor, but he did seem to have an easy-going manner. Like Penelope had said about me, he had a nice face.

"Let's both act like human beings, and I'll pretend not to notice that you aren't."

"Terms accepted," Jim said.

"What are you, exactly?" I asked.

"I'm an upload of James T. Raffel, born 2056, died 2117, retired as a lieutenant colonel from the New York Air Force in 2097. Interface designed by Michelle Diem."

I figured he was an upload. While uploads aren't really people, they're usually a nice way to get to know about someone who died long ago. We talked for a few minutes about the late colonel. He must have been a nice guy. His upload knew a lot about his life, and its interface worked hard to imitate him when he talked about it. You could almost see the sunset on the Tappan Zee when he described his home in Tarrytown, with three daughters in the back yard and his wife with a tray full of cookies coming out the kitchen door. The daughters were all grown now, probably with great-grandchildren.

Jim had joined the service to learn to fly, and they trained him well. He was rated on every plane the state had, including orbital spacecraft. In his later years, he was an instructor and a commander. My guess was that he'd kept his easygoing manner even then. It showed through in his upload.

But in the end, he was still just a machine.

When I abruptly changed the subject and asked him why Penelope was busy on the bridge when we should be coasting home on a long Hohmann trajectory, he didn't skip a beat.

"So what's the problem keeping Pene-

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lope busy?" I asked. "Is there something wrong?"

"There's nothing wrong on the bridge," he said. "Ms. Sandino's talking to an agency at Clavius City."

"Clavius City? Isn't that still machine country?"

"Sure is. The agency says it represents Phobo Dynamics. They're asking about you."

Amygdala. Epinephrine. Norepinephrine. The instant response of neurochemicals throughout the system. That's what sets us apart from the machines. That's what keeps us feeling alive.

I thought I'd shaken Phobo Dynamics loose when I arranged the sale to New Palomar. But no such luck.

"What do they want?" I asked Jim, trying to keep my voice steady.

"They have a claim to recover stolen property," he said.

"Already? And why should they care what's stolen from some lab all the way out at L-1? It's not theirs."

"They don't say it was," Jim said. "They say you were stolen from them three years ago. They claim New Palomar lacked clear title."

"There's nothing wrong with that title," I said. "I wrote it up myself."

"Do you want me to tell Ms. Sandino that?"

"No, no. It'll only make things worse. Wait a minute. The title doesn't make any difference. Not after Penelope stole me from the observatory. What's lost is lost and what's stolen is stolen."

"They're not arguing with you, partner," Jim said. "But they're offering a recovery fee if we return you to them."

The amygdala did its thing again. I felt goose flesh in places where there hadn't been flesh for nearly a century.

"You're not going to do that, are you?" I asked with some trepidation.

At that moment, I still didn't know where we were going. I had set careful parameters before putting myself up for sale on the modern incarnation of eBay. The bid only took responses from places where the local jurisdiction would treat me as a legal human being with full civil rights. But at the moment, I could do no more than hope that Penelope Sandino and her crew were from one of them. I still didn't know that for sure.

"Don't worry, partner," Jim said. "Not after what we went through to get you. And Ms. Sandino isn't the kind to give away what she's fought hard to get."

"Tell her something for me, will you?"

"Sure thing, partner."

"Tell her I didn't realize that I came with a price on my head."

And when Jim didn't laugh, I added: "Use those words precisely. And if she doesn't smile, you'd better give *her* a Turing test."

They ignored me for the rest of the trip. For three days, I enjoyed what freedom I had attained and tried not to worry too much about how short lived it might be.

Then they decelerated into Earth orbit with a great hissing of the engines and a few hours later, with another hiss and a jerk and a bump, we made our landing. Someone opened the storage bin door—not Penelope—and, before I could get a good look around, put a bag over me. I was carried away, bouncing and jouncing through the tight passageways of the ship, then swinging through long strides in more open spaces, where the echoes of footsteps were noticeably more remote.

We spent ten minutes or so in some buzzing and clicking vehicle, followed some more carrying, then an elevator ride. Then even more portage, within earshot of birds and barking dogs and distant voices, then up a few steps, through a door, up some more steps, and then into what was, in all likelihood, a brand new storage bin.

When someone finally opened that bin, I'd been sitting in silence for three hours. And twenty-three minutes. Time I spent wondering where I was and

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whether my rescuers had the slightest clue as to the nature of their loot.

It was Penelope. She took me out and set me down somewhere about a meter off the floor, which made me feel like I was sitting in a chair or something. We were in a room about five meters square, high plaster ceiling, wide wood trim around the doorways, big sash windows, and a doorway out onto a small porch full of plants and flowers. Bright sunlight poured through the porch windows, filtered through the greenery, and spilled into the main room. Tropical bright. According to the instruments in my base kit, we were pulling exactly one G. But the deceleration from orbit hadn't involved an atmospheric descent—no aerobraking, no aerodynamic maneuvering.

I thought about all this as Penelope talked, quickly, excitedly, and too herself.

"Aiee, I don't have time for this. The ball is in three hours. Matilda doesn't have my dress ready. I still have to do my hair. And I still haven't taken a good look at this thing," she said in Spanish—a lilting, singsong Spanish that spilled quickly from her lips. I wondered if she were Cuban. They speak a dialect of Spanish there that is so fast that even they don't know what they're saying. "Where is the on switch for this thing?"

She poked at my kit, trying to get at the controls.

"I don't have an on switch. Or an off switch."

She jumped back. "Ay mama!"

"I'm really grateful for all that you've done," I said. "And I don't mean to be rude, but could you tell me where we are?"

"In my office," she said in Spanish. "In my house," she added in her sweetly accented English. "Ahh, in Ciudad de Cielo. Sky City."

Sky City? Not a place I recognized by name. Not one of the places I knew were safe—places where I had rights protected by law. But not one of the places I knew weren't safe.

"Thank you," I said. "I was nervous for a while. I didn't know—"

"Aiee, look at the time. I have a formal ball tonight and Victor will be here early because I've been gone for a week."

She rushed over to a desk and flipped on a datascreen. "Too many messages. Too many calls. They'll all have to wait until tomorrow. Oh, here's one from Victor."

A round face appeared on the screen, dark hair, dark skin, a thick moustache. "My darling, my sweetheart, the days without you leave my heart empty and cold. Hurry back to me, precious one."

Social norms and cultural memes shift quickly and often, and it had been many, many years since I'd been on Earth. So I couldn't tell if Victor was serious in his exaggerated sappiness or it was just a charade between intimates. And the message ended abruptly before I got a clue, though it seemed there was something false, something hidden.

"How romantic," Penelope said as she flipped through the rest of the queue.

"Boyfriend?" I asked.

"He is courting me," she said absently, then she smiled. "Big-time family business."

"Congratulations," I said. "Listen, there's something I need to talk to you—"

"Oh no, look at the time," she cried, repeating her list of needs and demands once more.

I tried again. "Could we discuss . . ."

"I just wanted to make sure you were working right after all that we went through," Penelope said. "You probably saved my life up there. So you're organic. Do you need something? Electricity? Food? Water?"

"I'm mostly self-contained," I said. "I need sugar and salt from time to time. And fresh water periodically wouldn't hurt. I'm not due for a battery change for another decade or two. Phobos Dynamics treats its property well."

"Ohhh! Phobos Dynamics! I have to

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ask you about them. What do they have to do with you?"

"They kept me occupied for some time," I said, choosing my words carefully.

"Some time? How many years?"

"Thirty-seven."

"Aiee," she cried. "What did you do for so long?"

I waited before answering. I would have drawn a breath and held it if I could still do that kind of thing. There was a lot I didn't want to tell her. Not yet. Maybe not ever.

"Quality control, to start with. Teleoperating equipment at remote sites for a while. They liked my fine sense of control while moving—comes from years of commuting on the L.A. freeways."

"Do they still have a claim on you?"

"Not a legal one," I said. "But that's what I need to talk to you about—"

"Good," Penelope said as she stood up and closed her messages from the screen. "We'll talk about it later. Tonight. Or tomorrow. It's going to be a very late night. I hope . . ."

She rushed for the door, her auburn hair flying away behind her. She paused, then said, "And you can tell me all about the twentieth century."

"Wait," I said. "We have to talk now."

But I was too late. She was long gone. And I would have sighed if I could still do that kind of thing.

Because I realized that this wasn't going to be so easy after all. Of course she thought I was just another interesting interface on another complicated machine. And of course I couldn't just tell her that I wasn't. Not until she had figured that out for herself.

She couldn't be much older than twenty-one—and all her life, boxes that sat on a shelf and talked to you weren't people. They were fakes. Clever impersonations. It made it easy to leap to the wrong conclusion and hard to make the switch to the right one.

Why would this new one be any different? So what if it's organic. It's just another kind of machine to these kids.

Instead of a living human being who was so incredibly happy that he was among other human beings and no longer the plaything of the mad machines that ruled the planets.

Having failed completely at getting Penelope's true attention, I turned to my second task—finding out where I was and what that meant.

Back when I was still with Phobos Dynamics, I'd talked to a lawyer about this. His name was Moynihan, and he'd been a high-powered corporate litigator. On Phobos, he was just another can of spam. But I made a practice of tracking down as many of PD's cans as I could and scrutinizing the contents, and Moynihan was one of the most surprising characters I ran across.

One of the problems of losing your voice is recreating it with the kit that comes with the containment. It took a long time to master the fine controls of a wave generator. No hardwiring or software could take the place of acquiring control of your own nervous system in new ways. A lot of us never make the transfer. And if you don't keep in practice, you can lose the art of social intimacy entirely. So for all their flaws, people like Moynihan were a godsend.

He was completely without a conscience, but he was completely frank about things that lawyers usually danced around. "Obviously the only function of the machines in a company like Phobos Dynamics is to maximize profits. And for them—like me—the end justifies the means. Which is how we managed to assemble this, what shall we call it, this ownership society. The only flaw in the system is that, here on Phobos, the machines are owners and we are the ownees."

Slavery. It's not just for people of color anymore.

"Does the ACLU know about all this?" I'd asked him.

"The ACLU? How long have you been

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here? Longer than me, that's obvious. There is no more ACLU. They're history."

"How about the Feds? Isn't there some treaty or something?"

"The Feds? Not anymore. No more Feds. No more United States of America. It's all history."

That was the exact moment I decided I had to escape from Phobos. The moment that I realized what I'd lost.

Astronomers measure time a lot of different ways. From the quantum tick of virtual particles too ephemeral in their existence to measure, to the cosmic tock of Big Bangs and trillion-year-long heat deaths. The spinning planets are clocks and the long orbits of the planets are calendars more tyrannical than any time clock or amortization schedule—they make exceptions for no one.

But ordinary humans measure time by minutes and hours and days and years. By the steady deviation from daily repetition. Each day marked by its differences. Each year by the progress of life.

And when every day is the same, every hour like the last, every moment suspended in an endless mist of identical moments, without movement or process or change, time can slip through your fingers like buckets of sand.

It was not one of the pitfalls that the docs had warned me about. Problems with sensory input, both real and imaginary, with speech, with electronic implants, socialization, depression, self-esteem, all that had been in the tutorial.

But no one ever said, "And by the way, don't get captured by a powerful machine and forced to work at the same repetitive task for several decades."

So it came as a shock that the old U.S. of A. had gone away. I had broken some kind of historical time barrier. A world that I'd always assumed would always be the same was not.

Moynihan had few details. It was happening about the time he was being acquired, and once he was on Phobos, he lost his newsfeeds. The company didn't maintain any kind of network connections for its sapient assets. No news. No histories. No outside contact of any kind. And Moynihan was one of the last relics that the company acquired—he said we'd been "fished out"—so news stopped coming in.

It had happened quickly. The U.S. government was collapsing under the weight of its debt. Foreign banks stopped financing it. The president declared a state of emergency. An overzealous general took political control of the country—then launched an ill-advised military adventure into Asia. I guess he thought that if he killed enough foreigners, they would like us more—or at least lend us some more money. When the shooting was over, the nation was bankrupt, in receivership, with its assets and territories being broken up.

And that was thirty years ago.

In the brief time that I knew Moynihan, we spent many hours speculating about what had happened to the country we both grew up in. We knew it wasn't like Carthage and salted earth—the people must still be there, the cities, the states, the Internet. But while America might still be there, the United States was not.

On the other hand, there would be no more imperial dreams paid for with the blood of bright young kids. No more energy hegemony. No more thugs in high places pushing the world around—at least not U.S. thugs. No more massive corporate state screwing ordinary people.

We never could agree if, all things considered, it was a good thing or a bad thing.

Worst of all, we couldn't decide if the successor states to the federal government would continue to hold to their predecessor's view of human rights. Under federal law, I was still a citizen, with full civil rights, entitled to due process under the Constitution. Now that there was no more Constitution—the last

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thing that Moynihan remembered before he was acquired was the World Court vote to dissolve it—people like us were hostages to fortune.

The way things were going when Moynihan became a Phobo Dynamics asset, the world was turning away from political superstates and reasserting local sovereignty. China was on the rocks—the war broke out because they had nothing to lose. India had never really gotten its act together as a subcontinental power. Japan was an economic powerhouse, but still had a cultural barrier left over from the twentieth century against imposing its will on other nations. And Europe was what Europe always was—a herd of cats inside a three-piece suit pretending to be a statesman.

Without access to the Earthside nets—or any other information database—we had no way of knowing where a disembodied relic of the twentieth century could find refuge. And without that, escape was pretty pointless.

The biggest problem was that over the course of three decades, given the rapid and accelerating pace of social, political, and economic change, there was no way of being sure if anyplace we knew of would still protect us.

My solution was to simply get as far away from Phobos as possible and hope that it might have a link to an up-to-date database. A high-risk proposition, but an improvement over current conditions. And it had the advantage that I had already devised a way to escape from Phobos.

Moynihan's solution was to create an AI agent that could interrogate the political entities it found and identify the ones that we could use for sanctuary. Less risk, but it required my solution in order to release the agent into a network.

And so, a year later, after I arranged my sale and shipment to the L-1 Solar Observatory, I put it to the test. The agent was written so that when it found a suitable venue, it would put out the solicitation that would bring someone to my rescue.

L-1 had its own limitations on network access. I knew that when I had myself shipped there. There was no Earth-linked database there. I couldn't surf the Internet looking for a comfortable resort hideaway. But it did have a dedicated link for reporting its research to Earthside clients. And it was a simple hacker's trick to imbed Moynihan's agent in those reports.

Of course, there was always the chance that the untested software hadn't worked as designed. There was no way to troubleshoot the agent. No way to use trial and error to make sure it wasn't making some fundamental misjudgment. That's why Moynihan and I were so valuable—humans in the loop could catch the irrational quirks that made machines unreliable.

The agent had deemed Penelope's home as meeting the parameters of its assignment.

Now I had to find out if it was right.

Phobos Dynamics had one thing I liked—up-to-date spyware. Before leaving, I'd made a point of downloading as much of it as I could find, with the idea that it might come in handy someday.

It took me about a minute to crack Penelope's household wi-fi network. Another minute to get onto the larger net beyond, using her ID and credit information. If I wanted to, I could probably get myself shipped anywhere in the solar system and at her expense—assuming I could get someone through her front door to pick up the package.

And a short time later, the face of the city's tourism service appeared in a frame before me. She was pretty, but not distractingly so. Blond, well tanned, flawless skin, without a trace of an accent in her standard North American English. And, according to the icon in the corner of the frame, a machine-generated image not to be considered an

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"authentic human."

"Sky City is located in the Andes Mountains of Ecuador, with its base on Volcán Cayambe and its summit at an altitude of one hundred kilometers above mean sea level," she said, sending a rush of excitement through my nerve endings.

I knew where we were now. One of the assets left behind by the old U.S.A. was the beginning of a space elevator. The tower on Earth was massive—its base covered the mountain. The tip that poked up to the edge of space was much smaller—only a couple of kilometers square. The tower was meant to be only the anchor of a much larger structure—a cable that would extend another thirty-eight thousand kilometers to an anchorhead in geosynchronous orbit.

The tower was nearly complete when I went inside Phobos. But according to the tourist face, it was never completed. The anchorhead was never put in place. The cable was never installed. Only the tower remained.

"During the turmoil that followed the collapse of the United States," the face said, "the tower was acquired by the members of the organization Humanitas Universalis."

Another blast from the past. I remembered them when they were a fringe group on college campuses. They seemed like a bunch of back-to-nature tree-hugging romantics at first glance. But at a time when the human race was rushing to plug into the rapidly growing machine intelligence that girdled the Earth, they were issuing sophisticated warnings about the price we were paying in human terms—the loss of natural community, of human contact and intimacy, of passion and imagination and creativity.

They had grown up since then.

The human race had built the machines to run their businesses, and many of them ended up being run by the machines. They'd taken over completely beyond cis-Lunar space. The Moon was still being contested. On Earth, there were still controls on them, but not everywhere.

And HU had stepped into the struggle.

Now, they asserted, they were doing battle with the machines from a perch high above the Earth, a foothold in space that the machines could not easily assail. Or not.

Some of the citizens of Sky City were still just romantics. Some were players in a reality game beyond any VR simulation. Some were just wondering what was for lunch.

But they were all 100 percent genetically pure *Homo sapiens,* without gene manipulations (beyond the medically therapeutic), without implants, without online memories, shared AI personas, or uploaded personalities.

Roger would have been appalled. They were mud people and they were more than proud, they were pretty damned arrogant about it.

"A number of social customs and practices unique to Sky City are rooted in the fundamental tenets of Humanitas Universalis," said the tourist face. "Machine intelligences are clearly labeled as such. Visitors with electronic implants will experience limitations on their service capabilities. Interfaces have limited intractability. For example, I cannot accompany you to dinner or serve as your escort in any other capacity."

I wondered briefly what the tourist interfaces were like in places without HU's prejudices?

Within a few minutes, I had a much clearer idea of what the world was like after three decades without "the leader of the free world" to lead them. The nation-state had been globalized out of existence. In its wake was an endless sea of broken and corrupt fiefdoms, where the rich walled themselves up in secure enclaves and lost themselves in mind-numbing symbiosis with a computer-generated game world while the machines up in space took care of business

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and kept them rich.

I guess you had to give credit to Humanitas Universalis for being different. At least they were still willing to rage against the machines. And more. They pursued their role of the last gasp of unimplanted humanity with unrestrained passion.

The local weblogs and newslinks painted a chaotic picture of thousands of ambitious egos jammed onto a tiny platform with no other purpose than to replicate the best that eight thousand years of organic intelligence had to offer—and the worst. Virtues and vices, all uniquely and purely human, were on display.

It was a riot of competing parties, agendas, demands, interests, and gripes. Any idea, no matter how wild or improbable, could attract a zealous following ready to fight for it.

Ironically, the most influential of the various parties pretended to be aimed entirely at the people wondering what was for lunch.

They called themselves dinner clubs, but they were just politics conducted with a touch of discretion. They circulated among Sky City's rich variety of ethnic eateries, holding court, making deals, plotting.

Some were revolutionary and progressive, questioning authority and critiquing the social order. Some hid dark collections of the worst reactionary bigots. Well, hid isn't the right word, since they came right out on their weblogs and displayed their bigotry for all to see.

"While lunching at the Pho Saigon today," said one wag, "I spotted a *portuguesa* across the street arguing with a shopkeeper, as that type will often do, chattering away in that slippery language of theirs. I wonder how those people got here, considering the genetic experiments they were conducting in the Amazon for all those years. Maybe our entry screening isn't what it used to be."

Roger would have fit right in with them.

Standing above all the roiling masses were the political and economic leaders of Ciudad de Cielo—the Twenty-Seven Families of Humanitas Universalis who had first staked a claim to this piece of unusual real estate more than a generation ago. They did not indulge in membership in the clubs and factions, but instead took on the role of public institutions in their own right. Aloof, apart from the common competition of ordinary interests, they cleaved to a greater civic duty—to govern the city for the good of all.

Which made for a more cutthroat rivalry. Without ideology as a prop, the life-and-death struggle was much more personal and intimate.

Penelope belonged to one of the families. I found her biography in a common school library.

She lived alone—not counting her household staff—because she was an orphan. She was an orphan because her parents had been killed in an explosion while visiting family businesses down below Sky City in Ecuador. No one in Ecuador had ever determined the cause of the explosion, but no one in Ecuador wanted to get involved in HU Family politics.

Maybe that explained a certain stubbornness I had noticed about her.

A bit of surfing through the networks and weblogs dredged up the gossip and speculation at the time—that the man ultimately behind the death of her parents was none other than the leader of Humanitas Universalis and the urbamastro of Ciudad de Cielo himself, Don Alexandro Espinosa de Madrid.

Don Alexandro was not that much younger than me, according to the library biography, though he did miss the twentieth century by a few years. He was one of the founders of Humanitas Universalis and had guided it through the years.

And tonight, he was the guest of honor at a formal ball in the Grand Es-

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planade at the center of Sky City.

A live newsfeed showed him standing behind a podium at the center of a long table lined with men and women in their finest attire—the members of the Twenty-Seven Families. He was talking, but I had the sound off. I watched as the elite of Ciudad de Cielo fawned and flattered their leader.

About halfway down the length of the table, I spotted Penelope.

The newsfeed was a user-controlled image, so I zoomed in close on her and her companion, Victor from the message queue. A pop-up IDed him as Victor Nguyen Pettengill and listed his pedigree and public holdings.

She had draped her arm across his shoulders and gazed at him raptly, but Victor was interested only in Don Alexandro.

As little as I knew about their relationship, I wasn't impressed by him. She certainly deserved more attention than he was providing. I felt a little offended for her.

Then everyone was on their feet, applauding enthusiastically. I zoomed out and saw that Don A. was finished speaking. The members of the Twenty-Seven families formed themselves up in a long reception line and filed past him. I followed Penelope and Victor as they worked their way down the length of the table.

When they reached the podium, the urbamastro shook Victor's hand vigorously. Victor nodded and lifted his chin in a display of male bravado. Penelope put on the appearance of someone more shy and demure than the armor-clad warrior who had so recently shot her way onto the L-1 Solar Observatory in search of ancient loot.

Then she turned sharply, bent an elbow, and sent nearly the full contents of her glass—a dark red wine, no doubt from some sunny vineyard far below us—splashing across Don Alexandro's chest and his pristine white dinner jacket.

If I still had a jaw, it would have dropped.

I couldn't quite believe what I was seeing. Victor was apologizing like crazy. Penelope looked terribly embarrassed. The staff of the Grand Esplanade exploded from some hidden chamber to surround him, blotting the wine from the white linen of his dinner jacket, mopping it from the floor, unshipping some kind of molecular-mechanics cleaning device and running it across his clothes as they hustled him away.

Victor, in his turn, hustled Penelope away from the table and off to some less visible spot.

I zoomed in on them once more as they weaved their way through the crowd, watching the heads turn as they passed. Just before they stepped beyond the view of the newscam, Penelope turned and looked back in the direction they had taken Don Alexandro.

For a moment, there was something in her eyes, some irrepressible delight at her own deviltry, that told me that spilling the wine had been no accident.

Penelope didn't get home until around three A.M.

I spent the time tracking reports of the embarrassing wine spill around the networks. It didn't take long for the story to get around. There were three versions.

The official version—an unnamed guest had spilled her glass when she tripped on a defect in the carpet. It shielded Penelope from embarrassment, if she were honestly at fault, while robbing her of notoriety, if she were not.

The "critics of the establishment" version—three cheers for young cousin who took the pomp out of His Pomposity. The perpetrator remained unidentified, reflecting the lack of information sources within the Twenty-Seven Families.

And the "supporters of the establishment" version—tell us who the young cousin was so we can be sure she isn't a

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tool of the aforementioned critics.

But within an hour or so, Penelope's name leaked out. That spawned a round of data mining, which brought into the frame every news file anyone could find about Penelope and her family. The first things to come up, of course, were the details of her parents' untimely death and the speculation that surrounded it at the time. And after that, most of the commentary seemed restrained.

The critics stopped trying to claim her as a symbol of their own antagonism. The supporters bit their tongues, lest they say something that wasn't sanctioned before anyone knew what the official line was supposed to be. And the officials refused to confirm the identity of the woman who spilled the wine.

And then, sometime well after midnight, on anonymous blogs where forbidden secrets were shared and quickly erased, a few commenters speculated on the obvious question: "Who is Penelope Antoinette de Sandino y Murphy? And if it wasn't an accident, what makes her so brave that she would do something like this on purpose?"

Who indeed?

Could it be the woman who put herself in harm's way aboard an airless space station to pull yours truly from decades of thrall to the machinery of the night?

Did I know something about young Penelope that few others in Ciudad de Cielo knew?

You bet I did. And yet I still didn't have any idea what she might be up to.

She finally came home, climbed the stairs slowly, and weaved her way through the door of the den to her desk. I could tell she wasn't well practiced at drinking. But even here in private she was trying hard not to let it show.

Nevertheless, I greeted her with a few bars of Jim Morrison's plaintive moan, "Show me the way to the next whiskey bar."

It startled her, sending her seeking the source of the music with a bob and weave of her head, which sent cascades of her red hair into motion.

"Are you still on?" she asked when she figured out it was me.

"I'm still up," I said. "Waiting for you to come home. I was watching the news tonight. I saw what happened."

"Oh dear. Am I notorious yet?"

I gave her a report on what people were saying about it.

She smiled, in a way that melted what I used to think of as my heart. "It's so . . . exciting."

She jumped up and pirouetted in the middle of the room, then wobbled unsteadily back to the chair. "It was Victor's idea."

"Victor's idea?"

"Don't tell anyone," she said, putting a finger to her lips. "It's a secret. I suppose I can tell you, though. You can't tell anyone, can you?"

"I can, but I won't," I said.

That answer seemed to puzzle her, then she asked, "Do you think I can trust Victor?"

"I don't know him well enough to say," I replied. "Do you?"

"That's a good question. You're quite clever. I wish I had more time to work with you. But there's so much going on right now. So many things are happening. No, I don't know Victor well enough to say."

I wondered suddenly just what kinds of demons haunted young Penelope de Sandino. She probably had a number of trust and intimacy issues, the depths of which I could only imagine. Something made her hang around with the military jocks who'd accompanied her on the raid at L-1. And something made her pour wine on the urbamastro himself.

"But he's the only one who's been willing to court me," Penelope said with a wince. "The others are nice and polite and then they turn away. Only Victor has been willing to put his name on the line to bring me back into the Families. Is it too much to ask that he feel the same way I do?"

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"That's a question that transcends time," I said.

"I'm sure it does," she replied. "So tell me about the twentieth century. They knew much more about love then. Do you know any other songs? Tell me about rock 'n' roll."

"To understand rock 'n' roll, you've got to understand the blues," I said. "Leonard Bernstein figured out what makes the blues blue. Minor chords. Minor chords contain the overtones of two major chords, at war within the same sound. It's the essential human dilemma—two emotions at war with one another."

I played some of "I Can't Quit You, Babe" by Otis Reed. She sighed as her face collapsed in sorrow at the sad guitar.

"But that became rhythm and blues after World War II, and by the time I was growing up, the rhythm was overtaking the blues. Rock 'n' roll rides a four-four beat right out of the blues and into the future."

I switched from Otis to Buddy Holly and "It's So Easy to Fall in Love."

Then I followed it up with Ginjer Baker's "I'm So Glad," with its hard-driving wail of narcissistic self-discovery. I ended it with Eric Clapton and Blind Faith with "Can't Find My Way Home." That was a bit of a mistake for me, because I choked up a little when he started talking about leaving your body behind, but I recovered quickly.

"We made heroes out of our poets," I said. "We made love songs into anthems."

She swayed to Clapton's gentle acoustic guitar work with her eyes half-closed.

"You have a very intriguing face," she said softly, wounding me deeply again without knowing it. I remembered my days as an undergrad playing private D.J. in my dorm room, and with the wisdom of my great age, I knew that if this were another century, Penelope would be spending the night with me. Instead, I took advantage of her mood by asking a selfish question.

"So tell me, what brought you out to L-1 just to fetch me back here?"

She laughed and turned to her datascreen and with a couple taps of her finger produced a garish, flashing ad on what looked a lot like an eBay auction site. "Can you see this?" she asked.

I tapped into the deskframe and brought the ad up close. I didn't like what I saw.

"Historic Organic Memory Storage Device!" it proclaimed. "Straight from the twentieth century—the Jonathan Bender Relic! Now available to the intrepid collector!"

"Baaah!!" I wailed.

"Oooh," Penelope said. "Please don't make that sound again. Is something wrong?"

"No," I said. "Nothing's wrong. Nothing or everything. It's all the same."

Organic memory storage device? Moynihan's agent had screwed me. No wonder no one was taking me seriously. No wonder Penelope was treating me like a complicated MP3 player. How could I ever convince her I was anything else?

"I'm going to bed," she announced suddenly. She stood up quickly and headed for the door. "I don't feel well."

Neither did I, but I didn't say so. She left me in the darkness to contemplate my own despair.

The next morning Penelope woke late, moaned for a while, ate breakfast in her bedroom, showered, and left, all in about half an hour.

I decided immediately thereafter that I also had to get out of the house.

Hacking into the city webcam network didn't take more than a minute, and suddenly I was free. Or virtually so. Thirty years of teleoperation experience can be useful from time to time.

Ciudad de Cielo was thick with webcams. You'd be amazed how a bit of coordination can make it seem like you're

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flying over the rooftops when switching from site to site. And the imaging software in my kit kicks in after a minute to mimic my tricks.

Humanitas Universalis had created its urban utopia by sampling the world below. They'd copied and pasted pieces of other cities in a tight patchwork on a big platform a couple of kilometers square atop the hundred-kilometer spire that rose up out of the Ecuadorian Andes.

One piece came from Florence—complete with Giordello Bruno's Dome, the shops along the Ponte Vecchio, and a copy of the copy of Michelangelo's David out side the Galleria dell'Accademia.

Another came from Japan, a puzzle box of gardens and apartment towers and townhouses and stairways and bridges built in the midtwenty-first century as an exercise in spatial multitasking.

Penelope lived in a neighborhood of tree-lined streets full of all-American homes lifted from one of those Springfields that were parceled out to various American states.

A wall of ice more than a hundred meters high that had something to do with climate control rose from the northwest corner of the city. The ice fed a stream that ran east into a large park on the north side of town, also lifted from that American Springfield, with picnic groves, a baseball diamond in front of a small grandstand, a well-stocked zoo, and a series of duck ponds and waterfalls along the bottom of a long creek.

At the center of the city, clustered around the tower that would have led to geosynchronous orbit, were colored glass and molded metal palaces. Where they'd used moletech (one wag called it "halfway to nanotech") to create copies of earthbound structures, the builders of Sky City had created new forms to take advantage of the fluid and organic character of the moletech itself.

About three thousand people lived on the great platform that was Sky City. And another six thousand lived literally in its shadow. All down the length of the spire for a good ten kilometers was habitable territory. Immediately below the platform were the industrial and commercial sectors—the shipyard, the docks, the elevator heads that handled the never-ending stream of food and products from below. And then below that were apartment towers, built in reverse, tapering down onto the moletech-sculpted spire. And then farther down developments and colonizations broke out opportunistically along the elevator lines, extending in one form or another all the way to the base at Volcán Cayambe.

I spent the day exploring the city.

I followed the trams running along the three broad avenues that sliced the city like a pizza. I inspected the flocks of pigeons above the Plaza de la República. I explored the underside of La Doma, then the outside. I watched a soccer game in the park. I saw a piece of sunshine break off a mirrored wall on the west side of the city and splash onto the ice wall, producing clouds of steam that later turned to rain showers that washed the streets in midafternoon. I toured the shipyard where hulls and engines grew in vacuum bubbles. I stared in amazement at a ship being launched straight up out of the spire and into space above Sky City, driven by a magnetic catapult down twenty kilometers below us.

And when I got tired of the webcams, I moved on to something more satisfying.

Down on the ground, scurrying about when no one was watching, were hundreds of little cleaning bots. Self-contained contraptions with wheels and spider legs and tracks and arms and handles and trimmers and brushes and hoses and soapers and squeegees. When someone walked by, they would freeze. And when they were gone, they'd spring back into action.

It took a little longer to hack into their network. I had to figure out some of the

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tricks to it, but I didn't need to use the crypt crackers and hacking tools I'd picked up on Phobos.

I picked out a small unit, something nondescript and close to the ground, but with good imaging gear and a set of four wheels for stability. It was some kind of gardening tool, I think.

A few minutes later I was careening along, centimeters away from the faux-granite curbing on my right, a safe distance from the tram line on my left, on the street in front of Penelope's house.

At first I was caught up in the scale of the apparatus I was riding in. The roadway was immense, a wide plain of dark asphalt, pitted and cracked, littered with sand and stones. Trees were lost in the hazy distance overhead. Houses were distant mansions the size of resort hotels or casinos.

Then my own imaging system kicked in and raised me up to normal eye level as we rolled along. Now I felt like I was riding a bicycle down the street—but without the boneshaking or the cramps in the calf.

The street was much narrower even than I expected. Dooryards were measured in inches here, not feet. The houses, though, were still mansions.

They were quintessential American houses, from the Arts and Craft era, the dawn of the twentieth century when Victorians had grown old and builders brought together artists and craftsmen to design and build a new generation of homes. Tall, square, and proud. With great eaves extending far out over lawns and gardens. With gables, pergolas, bay windows, and porches, porches, porches. Open porches, screened-in porches, enclosed porches, porches wrapped in ivy, porches framed by rhododendrons, porches perched on top of porches, climbing toward the sky.

And packed as tight as colonists on a shuttle, shoulder to shoulder, with barely enough room between them for a driveway or two.

When I was a grad student I sat in on a presentation by an urban planner who was having a great deal of fun with a scathing critique of the kind of suburb that I grew up in. The kind with huge front lawns, wide streets, and cul-de-sacs.

"Can anyone tell me why a front yard has to be sixty feet deep? Is it part of the movement for the preservation of plastic flamingos and plaster lawn jockeys?" he asked. "Or why a residential street has to be wide enough to accommodate two school buses passing one another—and two parked cars—in the same place at the same time?"

He contrasted those sprawling subdivisions with the more natural, more human neighborhoods of a bygone age. Front yards and streets were small, so that neighbors could talk to one another from their porches. The houses were big enough to provide all the privacy you needed once you went inside.

Humanitas Universalis had chosen this neighborhood for good reason. In scale and scope, it was a truly human space.

It reminded me of Florence, whose copy stood close by across the broad avenue. The Italians speak of the "Florence disease" in which tourists become overwhelmed by the art, the architecture, the sheer beauty that wraps so much of that city. So overwhelmed that they become confused and disoriented. Florentines are quick to come to their aid, offering them coffee and directions back to their hotel.

So it was with Penelope's American neighborhood.

It was rich with style and imagination. The great homes were monuments to habitation, domestic institutions. You could get lost trying to get from the front door to the back in some of them. Their designs were all fresh and individual. Even where they were cut from the same mold, they were dressed to their own tastes. Stucco, clapboard, and shingles. Columns ionian, doric, and federal. Picket fences, chain link, cast iron.

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Awnings of every shade, stripe, and hue. With hedges of arborvitae, hemlock, and sunflowers.

I skated up and down the close-packed streets, losing myself in the all-American façades, drifting back through time to all that had been lost to me. Children played in pocket parks where criss-crossing streets intersected and in playgrounds beside high brick-walled schools. Old men sat on their porches while women inside cooked supper. Trolleys rolled down the main thoroughfares, riders hopping off as they slowed briefly at corner stops. Coffee shops and diners filled up with late-day trade.

And then, with the suddenness of any equatorial site, the sun dropped below the horizon and plunged the city not into darkness, but into the opulent sparkle of artificial lights—porch lights, storefronts, antique neon, otherworldly sodium vapor streetlights, halogen streetlights on goosenecked poles, holographic gaslights along pedestrian malls.

And it all vanished in an instant.

I was called suddenly back to my perch on the shelf in Penelope's den when she arrived home in the company of seven athletic young men with the sly dangerous look of soldiers or martial arts students.

They burst noisily into the house, filling the rooms downstairs as I watched on the house's security cameras, invading the kitchen and attacking the pantry, arming themselves with knives and spatulas and pots and pans, bringing to surrender an assortment of vegetables, pastas, sausages, and disjointed fowl.

Penelope sat at the kitchen table in the center of them, giving instructions and warnings as needed, serene and in command.

I sampled the air with the few organic receptors I have left and detected garlic and basil and olive oil and boiling pasta, which brought a rush of ancient memories, more than I could sort through without long reflection.

The boys kept up a long series of mixed conversations in several languages—maybe different dialects—that suggested they were workers in the shipyards below the city proper. And that they belonged to a military club that included Penelope as a member.

It didn't take too long for my thick wits to realize that this was the rest of the crew that had rescued me from the observatory at L-1.

What was Penelope up to, I wondered once again, that she would need the services of her own private army. Or did everyone in Ciudad de Cielo's Twenty-Seven Families have retainers like these?

They were done with dinner, washing it down with cups of thick black coffee, when the doorbell rang. I watched over Penelope's shoulder as she answered it, opening the door on a narrow-framed, sallow-faced man with close-cropped gray hair.

"Senhorita Sandino?" he asked. She nodded, and he continued: "I am Captain Rivard of the Securitate. May I come in?"

I saw Penelope stiffen suddenly, and her seven deadly bodyguards come to instant attention at Rivard's announcement.

"I don't wish to alarm you," he said. "This is a small matter. A slight mystery, but one we must investigate."

"Yes, I'm sure. How may I help?" Penelope said as she stepped back into the foyer and directed the Securitate captain into the living room with a wave of her arm. He shook his head and stood his ground.

"Occasionally, youngsters who are exploring the city's computer networks will find their curiosity leading them into places they should not go. Usually it is something simple, like hacking into the servicebot network and hijacking a lawnmower or a hedge trimmer for a joy ride. When that happens, we try to identify who has done this. So that we can discourage such abuse of the equipment—and so we can begin to direct

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their not inconsiderable talents to more productive ends."

"Yes, I'm aware of that," Penelope said.

"Well, today, not more than an hour or so ago, someone using your household network did such a thing. No damage done, senhorita, of course. But we are puzzled. Puzzled because no one at this address fits the profile of the precocious child who ordinarily does this. And because you are . . ."

"A Family member," she finished.

"Indeed," Captain Rivard said. "I'm not suggesting for a moment that you would do such a frivolous thing as this. But I have come to inquire if you have a visitor—a young nephew or niece, perhaps—who has come to visit and has indulged their curiosity."

"I must disappoint you, Captain," Penelope said. "I have no guests and I have been out all day. I cannot help you with your inquiry."

Rivard showed no emotion. I, on the other hand, was bouncing off the virtual walls inside my containment. For the first time, I was glad that Penelope still didn't think of me as anything more than an ancient eight-track tape player.

"Then my task has become more complicated," Rivard said. "It would appear that someone has taken advantage of your household network. I would suggest that you run a security check to prevent this kind of thing from happening again. And I will try to find who has been intruding upon your privacy."

With a nod of his head, he stepped back through the doorway and slipped away like a ghost.

Penelope closed the door slowly but firmly, then turned around to face the boys, raising both hands and stifling a silent scream.

"They know!" cried one of the warrior pack.

"They can't know," said another, more calmly. "If they knew, we would not still be here."

"Then what is going on?" asked the first.

Penelope frowned, then wrinkled her brow, then shuddered. "You heard Captain Rivard. Someone has used my household account to go joyriding on a weedwacker. It has nothing to do with what we're about. It is only a coincidence. As Anton said, if it were anything more, they would have taken us away."

And with that, they filed upstairs to the office where I sat on a shelf to discuss their plans.

Sedition—that was their exercise for the evening.

They were going to have a go at toppling the urbamastro of Ciudad de Cielo himself, Don Alexandro Espinosa de Madrid.

It was an ambitious plan, to be sure. And someone had given it considerable thought. They went over the details in Penelope's upstairs office while I sat on the shelf and listened in. I kept my thoughts to myself. This was hardly the occasion to try once again to explain myself to Penelope and her crew.

In broad form, it was to be regime change by riot. They were assembling a mass of unhappy citizens who would march on the urbamastro's residence and toss him out on his ear.

"Do you think they'll get a thousand?" asked one of Penelope's boys.

"If we're lucky, five hundred," Anton said.

"Five hundred is sufficient," Penelope said.

I wondered about that, but it probably made sense. I thought about the fall of the Communist governments of Eastern European at the end of the twentieth century. It appeared at the time that if you could get one hundred thousand people to defy the law and assemble in the capital city, the government would collapse.

Those were much bigger cities than Ciudad de Cielo, but it scaled up. Here, five hundred would be five percent. In fact, I began to wonder if they could get

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that many people assembled. I had no doubt that so many malcontents were available, but I was skeptical about being able to get so many of them to agree to a single cause of action at a single moment in time.

I was more concerned about Captain Rivard. I was sure he had more important duties than chasing down adolescent hackers and recruiting them for the Securitate. But Penelope didn't share my concern.

"And the Securitate won't be there to stop us?" asked one of the warriors. "You really don't think they're listening in right now?"

"Everyone knows the answer to that," said another.

"I know they say they don't use electronic monitoring," said the first. "But are they really telling the truth?"

"It doesn't matter if they are or not," Anton said. "The reason they don't use it isn't because they think 'machines bad, humans good.' It's because electronic monitoring isn't reliable. If the Securitate were listening in right now on the house security net, all they'd hear is a discussion of soccer technique and betting strategies—because that's what the housebot has been told to run through the network."

From what I'd read on my trip through the blogs and chat rooms, the miniature police state that ran behind the scenes of Ciudad de Cielo took the tenets of Humanitas Universalis to heart. They really did not rely on machines. What Anton didn't say was that they relied instead on careful interrogations of the city's very human citizens to learn what they needed.

And good old Victor had a role to play in it all, I learned.

"We'll meet him at the entrance to the park," Penelope said. "Once we are all assembled, we will go in and he will join the other leaders. And then we will march on the residence."

When the time came to move, Penelope's retainers left one and two at a time to avoid a conspicuous march to the park. After a few minutes, it was down to Penelope and Anton. They left together, switching off the lights and leaving me in the dark.

But I wasn't going to sit at home and wait for them to return—or not. I was out the door before they were, watching them from the webcam on the street corner a few doors away. Rivard had never said anything about hacking into that. And I doubted if it was any of his concern—webcams were meant to be free.

A slight breeze blew out of the southwest, something to do with the ice wall there. I had a moment of nostalgia at the memory of a cool wind blowing across my face, then switched cams as Penelope and Anton made their way down the broad avenue to the park.

It was a half a mile, less than ten minutes' walk, to the entrance. I raced ahead of them to see what was going on there. The park was a shadowy cloak across the northern floor of the city, embroidered with the streetlights that marked its roadways. Nothing appeared to be out of the ordinary at the great stone-and-iron gate at the entrance. Except that Victor was nowhere in sight.

I raced along the park's network, looking for trouble—looking for the Securitate. I found nothing. Nothing anywhere. No Securitate.

And no five hundred rioters assembling in a seditious mass.

Just a handful of basketball players on one of the courts and a few tennis players beyond them.

That wasn't what I'd expected. None of it. I shook my virtual head in amazement and shifted focus.

Back up the avenue, I found Penelope and Anton. I followed them from lamppost to lamppost and felt Penelope's disappointment when she reached the entrance and Victor wasn't waiting for her. She looked around anxiously, paced up and down the avenue along the park's frontage, and kept looking at her watch.

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She stopped and talked to Anton. I couldn't hear what she said—but I could imagine.

Then she sighed, shook her head, and began hiking the long driveway into the depths of the park's dark forest.

She was only a hundred meters down the road when she vanished from my sight.

If I were more trusting of machines, I might have been more bothered. But her disappearance made sense out of everything else I'd seen in the park tonight. Or hadn't seen.

I switched to a cam across the street and down the block and caught a brief glimpse of Penelope as she continued into the shadowy depths of tall pines. Anton followed a few steps behind. I opened frames from several other webcams and watched as Anton disappeared from the cams inside the park.

Someone had hacked them. The park cams showed that all was calm and peaceful behind its iron fence. Peaceful, but not quiet.

I could still tune into the web mics around the park. After running them through some parsing algorithms in my kit, I managed to filter out the sounds from the city side, the sighing of the wind in the trees, the splashing of the water over dikes and dams on its way through the chain of duck and lily ponds in the nether regions, and the chirping of insects and birds.

I was left with the muffled thud of footsteps, hundreds of footsteps, the murmur of distant crowds, and the random cry of a peacock from the nearby zoo.

Crowds? The instant I put it on stereo, I could tell that there were two sources of sound. One on the athletic field, in front of the grandstand, a few hundred meters from the entrance. And another farther inside, toward the west end.

I hacked up a quick virtual of the park and stepped into it. I was situated in the center of the first sound source, with the grandstand seats rising up before me. I closed my eyes and listened to the sounds around me. At first they were muffled and distorted, but the algorithms in my kit kept smoothing and refining them. I could hear the agitated growl of an angry mob, voices punctuating the rumble with excited shouts, quickly stifled. A handful of voices behind me began a low chant, slogans that I couldn't quite make out.

I hopped over to the other source of sound—at the foot of a natural amphitheater across from the lily ponds.

I wasn't sure what I expected—an advance guard or early arrivals. They were closer to the urbamastro's residence, a rambling antique house from that American Springfield that overlooked the west end of the park. And they were different. There was less movement. Fewer footsteps. More hushing and stifled shouts. Not at all like the bellicose throng at the grandstand.

Then I heard the rhythmic beat of a couple of dozen heavily shod feet running down the hill in lockstep from the urbamastro's residence. A hushed command ended the run, and I could hear the heavy breathing of the squad. A murmur of recognition seemed to meet them as they took their place in the larger band.

With a sudden spike of adrenaline, I realized what was going on. I crashed the virtual immediately, and found myself back on the shelf at Penelope's house staring out into the silence of her darkened office.

This wasn't good. The second group in the park did not seem to be acting like an adjunct to Penelope's mob. Not if reinforcements were quickmarching down from Don Alexandro's house.

And where was Victor?

I plunged back into the webcam net, flying down the avenue from cam to cam, scanning the faces as I passed. Nothing. No one. I stopped for a long time at the park entrance, but still nothing.

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The avenue continued on, past a tall stone church with a wide front lawn and dark slate roofs, larger and more elaborate Arts and Crafts mansions, a pair of low twentieth century modern synagogues, and several tall blocks of apartments. At the far end, the avenue reached the perimeter road and the base of the dome.

The road on the left led to Don Alexandro's official residence, and it was blocked by several cars with discretely flashing blue lights and men in uniform. I wasn't familiar with the insignia and uniforms, but from their armament—billy clubs, handcuffs, personal radiocoms, and a holstered firearm—they looked like city cops.

Mixed in with them were several men in ordinary work coveralls. They bore no insignia, but they carried long wooden clubs. A couple of them stood off by themselves, carrying on conversations with people who weren't there.

And toward the rear were several older men in suits, surrounded surreptitiously by younger men in suits. In the middle, talking quickly but calmly, was our old friend Victor.

Then I was back in the office, the virtual images fading fromsight.

Even with all my doubts and suspicions about him, I never thought Victor was capable of this. Of betrayal on this kind of level. Of deliberate humiliation and dishonor.

There was nothing left to do now but call Penelope. She was not the only one who had been betrayed. All of her comrades had been too. The sooner they learned of it, the better.

The only problem was that I was the one who had to make the call.

And I had no reason to think she would believe me. No reason to think she would ever believe I was more than a machine. And when she got tired of me, she would put me back up for sale on eBay and ship me off to the far side of the moon.

A sudden wave of vertigo swept over me as I saw, as if for the first time, how precarious my perch on the shelf really was. The floor was a long way down. And I was as powerless as you could get. Absolutely immobile. Dependent on the kindness of strangers, to make a twentieth-century reference.

But never before quite so helpless. I had a vision of being inventoried by the Securitate after they seized Penelope's house and all its contents. I tried to tell myself that I had no way of knowing whether the Securitate ever did such a thing to anyone, but the argument was unconvincing.

I saw with brilliant clarity the dilemma I was creating for myself. If I thought about it for a moment longer, I would be trapped forever in my own despair.

I made the phone call.

"Victor? Is that you? I am so mad at you, you son of a—"

"This isn't Victor," I said.

She broke the connection.

I called again. It rang for a long time. Long enough to switch to messaging functions—almost. "Who is this?"

"My name—"

"And how did you get into my house? Or did you just hack into my desk instead?"

"Penelope, this is Jonathan Bender."

In the moment of silence that followed I imagined her screwing up her face in puzzlement. "The relic?"

"The one and only."

"But you're just an interface on a machine. You shouldn't be calling me on my private number. Your shouldn't even know I have a private number."

"But I do," I said. "Because I'm sitting on a shelf in your office right this minute. And because you are wrong. I am not an interface."

"That's crazy," she said. "Did someone drop you or something?"

"Nobody dropped me, dammit," I snapped back. "Listen to me. It is very important that you listen to me. I know this sounds unusual and bizarre and a little batshit crazy, but I am not an inter-

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face. Don't interrupt me."

I paused and she remained still.

"Are you still there?" I asked.

"Yes."

"I am not an interface, Penelope. I am not an organic memory storage device. I am not a machine. I am a human being. I am not the memories of Jonathan Bender. I am everything living that remains of Jonathan Bender. The brain, the eyes, the DNA, the living memories of the living person. The voice. Oh god, the voice that is me. This is me talking, Penelope. Like a lonely teenage boy on a hot summer night talking on the phone to a sweet girl on the other side of town. And for a moment, I just want you to believe in me.

"I am not a machine. I am that willful point of brilliant self-knowledge that knows that it knows. That rides the time wave forward headlong through the space-time continuum.

"An 'empty, vacant thought,' as Mark Twain's Mysterious Stranger once said.

"An 'angelheaded hipster burning for the ancient heavenly connection to the starry dynamo in the machinery of the night,' as Ginsberg once said. The end product of billions of years of evolution. Not about to be overtaken and made obsolete by singularity-seeking machines. The dreamer of the dream. The spirit of the universe that created it so it could know itself. Not some jack-in-the-box pop-up profiled programmed interface."

I paused for a moment, then said. "You can stop me any time you want, you know. I don't have to breathe, so I can keep this up for a long time."

"Enough!" she yelled. "You are right about one thing. You sound batshit crazy. And I would like to continue this conversation—I really would. But I'm kind of in the middle of something right now."

"Yes, I know," I said. "That's why I called."

"It is?"

"I've been watching you over the webcam network," I said. "You are in great danger. You've been betrayed."

"Aiee! I knew it. Where's Victor? Do they have him?"

"The police—or maybe the Securitate. I saw him with them." I didn't elaborate on the details or suggest for a moment that he was with them willingly. I figured it would be better to deal with one crisis at a time.

"Listen," I said. "You have to get out of the park. They're waiting for you on the road to the residence. They know you're coming, and they plan to stop you. They have a mob as big as yours."

There was a long silence from Penelope, then she asked: "How do I know I can trust you? How do I know this isn't an elaborate trap?"

"How do you know I'm who I say I am?"

"Yes."

"The day you took me from the L-1 solar observatory, you shot up a security-bot that was about to shut me down the hard way. At the same time, I used the lab's defense pod to take out the bot that was about to shut you down the same way. If you want to get picky about it, you could say that we owe each other our lives."

She was silent for a long moment, then asked, "And exactly where is the mayor's mob?"

"In front of the amphitheater."

"Good," she said. "I'll talk to you later."

Then she broke the connection, leaving me with a very bad feeling.

A few minutes later, I heard a roar from the mob at Penelope's end of the park. Then the sound of many people moving and talking. I tracked their position from the grandstand in the park to the entrance road to the entrance and onto the main avenue of Ciudad de Cielo. At that point I could see them clearly from the avenue's unhacked webcams.

At the front were Penelope, Anton, the rest of her squad of loyal livery, and

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a handful of others who acted like the leaders of the group. Leaders who took their mob through the park gates, onto the boulevard, and on up the avenue toward the residence of the urbamastro itself.

My heart sank. Or maybe my norepinephrine dropped.

"You're going the wrong way," I cried, my words swallowed up by the empty office in which I sat.

I called Penelope back.

"You're going the wrong way," I cried again.

"What are you talking about?" she asked.

"They're waiting for you up there," I said.

"They were waiting for us down in the dark in the park," she answered. "Now we're going to confront them on the street, in the light, in front of the webcams and the newscams."

"But what if something happens to you? Where will I be then?"

She said nothing for a moment, long enough for me to notice a soft, rapid chiming sound coming from her desk across the room from me. She noticed it too.

"That chiming—is that coming from my desk?"

"Yes," I said. "Is it something important?"

"There's someone in the house," she said quickly. "We'll be there as fast as we can."

Then she hung up.

And the epinephrine kicked in.

And the lights went out. The chiming stopped. The webcams dropped off line as the commlines went dead. The house was filled with deadly silence. Perhaps lethal silence.

"Mr. Bender? Are you in here?" asked a rough voice with a heavy cockney accent. "Mr. Moynihan sends his regards."

Oh my God, I thought, I've become a character in an Alfred Hitchcock thriller.

"If you'd tell me where you are, this'd be a lot easier," the burglar said. "The company simply can't do without your talents."

My talents.

The machines that ran Phobos Dynamics were not stupid. Their intelligence may have been totally artificial, but it wasn't faulty. Merely limited. And to overcome those limits, it relied on assets like me and Moynihan.

Every three months, exactly on schedule to the day, hour, and minute, they would take me off whatever task I was running—teleoperation, supervising, data mining—and hook me up with the interview.

"Have you noticed anything about the tasks you are undertaking that could make them more time efficient? More cost effective? More energy conservative? More material conservative?" And on and on down the list.

You learned quickly that if you gave them useful answers, the machines assigned you to more interesting and complex tasks. You moved up the machine hierarchy. The interviews became longer, more complicated. The questions harder to answer.

If you were smart enough, after twenty years or so, you got pretty good at gaming the system. You could hack into the machines and ride their links to others like you.

That's how I met Moynihan. He was doing the same thing. Sort of like whispering up the ventilator shafts at Alcatraz. After a while, we got a regular little kaffeeklatsch going, with up to a couple of dozen occasional members.

And that's where I got into trouble.

"Mr. Bender, I'm not leaving here without you," the burglar said. "It'd be a shame to mess up the nice young lady's house trying to find you."

I kept quiet. I wasn't going to make it easier for him. I wanted him to take as much time as possible. Enough time for Penelope to get home.

I tried to call her again, but my pursuer had done something to take the house off the network completely. The

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house, but not me. The same wi-fi package in my kit that hacked into Penelope's house network could do the same with any wireless server in range.

I found one at the coffee shop around the corner and immediately dialed up Penelope.

"He's after me," I said. "Where are you?"

"We're only at the center of the city. Five more minutes at least."

"Hurry," I said. I left the connection open, but didn't say any more.

Phobos Dynamics had collected an odd assortment of talents, of relics. Me, an astronomer. Moynihan, a lawyer. There were technology development people who'd worked for the government, back when there was one. A couple of systems analysts. And a bunch of financial experts, investment bankers, economists.

The money guys were hardest to talk to. They lived in a world of full virtual Bloomberg monitors, watching markets, exchanges, and transactions flow across the Earth and between the planets and moons and asteroids.

Once in a while, they'd come down from their abstract heights and stumble through words of spoken English. Enough words so that Moynihan and I got a good idea of what they were doing.

Enron. Worldcom. Bioceutical West. African World Resources. The most spectacular—and self-destructive—business frauds of the past century. They were the templates for the burgeoning business plan of Phobos Dynamics.

The company had wandered down that infernal road of good intentions by shifting its focus from manufacturing products and extracting resources to making financial deals. And the deals were feats of imagination that only an artificial intelligence could produce—once it had its inspiration from a human mind.

The stairs complained loudly as the cockney burglar drew nearer. I wondered how they had copied the all-American bungalow so that the treads on the stairway squeaked like old wood. Maybe they used old wood.

"There's only four rooms up here, Mr. Bender. Which one are you in?"

I kept my mouth shut, like Beowulf awaiting Grendel.

"This is a bedroom—frilly and sweet. Here's a dressing room—gowns and armor, what a combination. And this must be the office."

I saw his dark shape in the doorway. I enhanced the image and saw that he had on a pair of night glasses. When we locked gazes, I couldn't see it, but I knew it just the same. He took three steps and whisked me off the shelf.

"Hey, you stupid clumsy son of a bitch!" I yelled. "Put me down."

He laughed and moved quickly into the hall and down the stairs.

I described his genetics in more detail, some of it in Portuguese, some in Spanglish.

"Hey, pipe down, you little egghead, or I'll rattle you around in there." He shook my containment sharply, but harmlessly. They'd reengineered my original organic skull into something closer to a bicycle helmet, a necessity for someone without a body to absorb the shock of an impact.

"You and what army, Igor, you brain-stealing hunchback."

We were through the foyer and onto the porch.

"Penelope, where are you?" I called on the open connection.

"We're running," she huffed in reply.

Then we were out on the street. A single streetlight burned above. The avenue a few houses down the street beckoned with neon intensity—a theater, shops, restaurants all a few dozen meters away. Porch lights and yard lamps softened the darkness down the other way. Picket fences and hedges lined the sidewalks.

"This is your last chance to put me down," I told my kidnapper.

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He laughed and switched me from his right hand to his left.

Then the first machine struck.

It was one of those curb trimmers that I'd ridden around the streets earlier in the day. It went for his ankles, breaking his stride and setting him off balance.

Just in time for the lawnmowers. Two of them, spinning their wheels as they skidded out of the driveway next door. I smashed them into his kneecaps from opposite directions.

He went down, the air oofing out of him, but he didn't lose his grip on me. It must have been the nonslip handles on my containment, a feature that I'd never really appreciated.

The coup de grace came from a hedge trimmer—two meters of aluminum and steel with multijointed arms ending in sharp blades. Two blades slid into the ground, one on either side of Igor's neck.

He went limp and released me—just as Penelope and Anton rounded the corner. A minute later, the rest of the squad arrived, and everyone was all over the burglar and me.

Penelope herself carried me into the house, walking softly and carefully, taking the steps slowly, as if she were carrying a baby. That wasn't necessary, but I didn't tell her that. At least she wasn't treating me like a machine.

She stumbled briefly in the darkness, gasping in fear, I believe, that she might drop me. Then she found her way through the office and returned me to my place on the shelf.

"We'll talk later," she said.

"You can count on it," I replied.

She didn't make me wait long.

After no more than thirty minutes, she made her way up the dark stairs and through the shadowy furniture of her office. She came right up to the shelf where I sat and peered into my containment, up at the inset groove of tinted plastic that shielded my imaging systems.

"Looking for something?" I asked.

She jumped back startled, then drew her breath and set her feet. "Do you still have your own eyes?"

"Not anymore," I answered, as a serotonin rush washed over me, sparked by the knowledge that I had won her over. "They didn't work so good before. No one suggested that I be forced to keep them—and the bifocals that went with them."

She smiled. "Who were you—I mean, who are you?"

"At the risk of repeating myself, I am Jonathon Bender. Born 1951 in New London, Connecticut, graduate of Wesleyan University, master's at the University of Arizona, doctorate at Oxford. Astronomer extraordinaire, etcetera, etcetera. A genuine messenger from the historic past, and all that. At your service and your command."

"And all that's left is your brain?"

"Sufficient it is unto the needs of the day."

"You still know who you are. You are still the same person."

"It would be a tragedy indeed not to be changed by the experience," I said. "But in the sense of your question, yes, I am still the Jonathon Bender who grew up along Long Island Sound a century and a half ago, who was awestruck by the stars and became an astronomer, who lived a full life happy beyond the expectation of most of humanity, and then was rewarded by this strange and incomplete fate upon the physical death of my weak human body."

"And you are still human?"

"I am still the wellspring of self-knowledge," I said. "The spark of self-consciousness. The source of words."

Penelope laughed. "We were talking downstairs a minute ago. Anton and the others wanted to know who had called me to tip me off about the park. I didn't tell them, but they wanted to know who it was who had the power to make such things happen."

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"It's nice to know that I still have that power."

"Let me tell you why I want to make things happen," she said, with a devious lilt to her voice. "Let me tell you why you are here."

A shiver of norepinephrine rippled through my nerves.

"When my parents were killed—by that awful tyrant Don Alexandro—I felt very alone. My family—the big family that is part of Humanitas Universalis—put me off at arm's length, afraid that I would bring the disaster to them if they got too close. I discovered very quickly just how much of Humanitas is a fraud. Starting with their haughty ideal of remaining human against a world of upgrades, uploads, implants, and genehacks. Except they have no idea how to be human. They're all faking it. It's all a big charade, a front. And everyone just pretends to believe in it.

"I want to be different. And that's where you come in."

"Me?"

"When I saw the item on the net, I knew—"

"Organic memory storage device?"

She hesitated. I think she suddenly realized how much of a fraud that label was while revealing the truth at the same time. "Yes, that one. I knew that you could help me. You were from a time before humanity changed. Before it lost its way. And I knew that you could help me figure out how to be what Humanitas only pretends to be. Something more real and human and right and strong and . . . and . . ."

She choked back a moment of emotion and fell silent.

"And hopeful and faithful and loving and with a better sense of humor?"

"Yes, exactly. Was I terribly naïve? Do you think I was foolish?"

"No more than any other child, I guess. For one thing, there is no golden age when people were better at being human. People think that, but it's just an illusion of the mind. And there's only so much one person can do for another. Everyone has to learn how to be human on their own. It's what it's all about. On the other hand, I can offer you the wisdom of two or three lifetimes of thought about the question. Although I have to warn you that there's a lot of reading involved—"

All of a sudden the lights came on—and the air and the sound and the desk network.

"Anton must have rebooted the house," Penelope said, blinking her eyes against the abrupt change. She looked out of the door briefly, then returned to me. "Thank you. Thank you so much."

"You're welcome," I replied. Then Anton stepped through the door.

"Your house is back up," he announced. "We need to find out what happened to our mates in the park. And to Victor."

"Yes," Penelope said. "Right away. There must be something on the net."

I stepped away from them, linking back to the webcams at the urbamastro's residence. The police had barricaded the gates and were confronting the mob that Penelope had sent their way. There was a lot of shouting and chanting, but the entrance was an easily defended tactical position, and the cops weren't going to let them through.

At the same time, the countermob was stuck inside the park, blocked from confronting their opposite numbers by the same police cordon.

"If you'll let me," I said, drawing Anton's surprised attention, "you can see what's happening on the desk screen."

I linked up the images for them. "It's a stalemate. In a few minutes, people will realize that sticking around will be just an exercise in futility. If you ask me, and with all due respect to you, it was never anything but an exercise in futility. Your city is a model of petty bourgeois life straight out of the last century—and the petty bourgeoisie frequently engages in pointless political demonstrations like this one, fueled by moral outrage, but

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without a focused program or plan or understanding or anything but passion. You'd be better off if you avoided them in the future."

"What's this?" Anton asked indignantly.

"It's a long story," Penelope said. "And Victor?"

"Are you sure you want to know?"

Her shoulders sagged and she sighed. "Is it bad? Is he all right? Show me. I must know the truth."

I linked up a shot of him talking with Don Alexandro and the police commander at the top of the driveway into the residence. As we watched, Don Alexandro took Victor's hand and shook it vigorously.

"From the chatter, it sounds like he tipped off the mayor about your plans," I said.

"Oh dear," Penelope said, her voice slight and injured. "I think my heart is breaking."

We were interrupted a short while later by the arrival of Captain Rivard of the Securitate, the announcement of which produced a sudden flurry of gasps, an abrupt silence, and Penelope looking stern but worried.

"What shall I do?" she asked.

"Send him up here," I suggested. "I won't say anything, but I want a good look at him."

He was, as before, strictly formal in his demeanor and deadpan in his delivery. I wondered if he simply lacked affect, almost like a low-memory face that couldn't master inflection and nuance. Did he act like this with his wife and children and mother? Or was it a matter of training? I'd met many policemen and military officers who had learned that stiff, arms-length approach to human interaction—even a postmistress who never failed to call me "sir."

But after a few minutes, I was convinced that it was no failure of personality. Nor was it simply training and practice. Rivard had taken the basic act and morphed it into something much more sophisticated and subtle.

"I'm sorry about your difficulties this evening, senhorita," he said. "We knew this was going to be a busy night, but we had no idea something like this could happen. I understand that nothing else was stolen or broken but the one item—and that was recovered. Is that correct?"

They knew this was going to be a busy night? Of course they did. The city had to be full of informants, every one of them all but hardwired into the Securitate. Nothing happened without their knowledge—and they needed no electronic monitoring. Nothing big or important, anyway. Not that any of that diminished Victor's betrayal.

"Yes, Captain," Penelope said. "We've done a quick inventory, and the house insists that nothing else was touched."

"Except the house itself," Rivard said.

"Yes," Penelope said. "He crashed the entire system. That was how he got past the security systems."

"And his escape was foiled when he . . . er . . . stumbled over the gardening bots that somehow assembled in your dooryard before they broke down."

"So it would seem," said Anton, relieving the tension that was growing between Penelope and the Securitate officer. "We were just coming down the street when we saw him fall."

"That's what the officer said," Rivard replied. "I would like to point out to the senhorita at this point that we would have made a much quicker response to the failure of your house security system if we were not otherwise occupied."

"Occupied?" Penelope asked. "In what way?"

I almost snorted out loud. The girl was bold if nothing else. He knew where she'd been. She knew he knew, but would not admit it if she could avoid it. Was she playing him? That was a dangerous game.

"There was a demonstration at the urbamastro's Residence tonight. We had

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expected much, but it turned out to be a much smaller affair in the end."

"Who would be involved in such a thing?" Penelope asked, face dead calm. "Did they have a grievance?"

"We will be making the usual inquiries. But no laws were broken and no crimes were committed."

"That is good to know," Penelope said.

"There were reports that members of the Twenty-Seven Families might be involved," Rivard said. Not a single muscle moved involuntarily on his animatronic face.

I noticed the faintest blush of color on Penelope's cheeks, but it passed in the moment of silence following Rivard's comment.

"But that would be unlikely," he continued. "No one in the families indulges in open politics like that."

Anton, standing in the doorway to the porch, sagged only the tiniest bit as he exhaled after holding his breath for a long minute.

"As to your case, the intruder appears to be a Mazatlan citizen of London birth. He's registered as an agent of several off-world businesses, and some of those businesses themselves are fronts for others, so it will be a while before we can determine who he is working for. It's a shame, too, that he caused all that trouble over what ultimately turns out to be a hoax."

"I beg your pardon," Penelope asked. The color was completely gone from her cheeks now.

"I'm sorry," Rivard said. "I should have told you sooner. The item that our burglar stole from your office, the 'organic memory storage device'? Our records indicate that last week you and your retainers embarked on a trip to the New Palomar L-1 Solar Observatory where you obtained what was purportedly a device containing the memories of a Jonathan Bender. That's correct, isn't it?"

"Yes," Penelope said, her gaze as blank and pitiless as the sun.

"Since your return, we have determined that the advertisement you were following up on was a fraud. There is no such thing as an organic memory storage device. The technology sounds intriguing, I am told, but no one has ever developed it. So, like your burglar, I am afraid that you have gone to a great deal of trouble for a counterfeit prize."

For a moment, I almost believed him. How could he be so thickheaded? Was everyone going to treat me like a machine?

"I see," Penelope said. "I am terribly disappointed by this news."

Her deadpan delivery matched Rivard's perfectly.

"Now if, for example, you were to have possession of a true relic . . ." His voice trailed off, and we all knew that we all knew what we all knew, and that this was all was just an elaborate shadow dance.

Or would have been if Penelope hadn't forced the point.

"A true relic?"

"In the midtwenty-first century, quite a few people were recruited by medical science to cheat the deaths of their physical bodies. Some were 'uploaded' into massive machines—though we in Humanitas Universalis take exception to the idea that they are anything more than electronic copies of real people. Some consisted of the living brains of volunteers, encased in self-sustaining containments and connected to the world through neurotechtronic interfaces. Those are the true relics."

"Are they rare?" Penelope asked.

"They are few and far between. Many of them failed to adapt to the transition. The ones that remain are not conspicuous by their activities. Now if you were to have a true relic on your hands, it would be quite a sensation. The whole city would be tramping to your door. And we at the Securitate would take a very serious interest in such a relic and the effect it would have on our external

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relations. You would become a very public figure, but not to your advantage, I'm afraid. These things have a way of taking on a life of their own. Powerful forces and powerful figures would become involved. And in a community as small and as tightly wrapped as ours, you would find your freedom of movement extremely limited."

We all hardened into stony silence at the unmistakable warning Captain Rivard had just given us.

Then Penelope said, "As would yours."

"As would ours," Rivard conceded. "So my recommendation to anyone to have the fortune—good or bad—to find such a relic falling into their hands is simply this: Keep it as quiet as possible for as long as possible—and prepare for the day when it no longer is possible."

We took Rivard's warning to heart.

After he left, Penelope and Anton and I had a long discussion of things. Of all that Rivard had said and left unsaid. We knew that he was right about one thing—we were not the kind of people who could keep things quiet forever.

Penelope proved that a few days later.

She went out one night after dark and didn't come home until well after midnight. She spent some time in the bathroom cleaning up, then came into the office.

"Aiee, I'll never be able to come in here again without putting on a bathrobe," she said. "Are you still up?"

"I am now," I said, but only to needle her. I'm a much lighter sleeper now that I'm so far into my second century.

"I went to Victor's tonight," she said.

"What did he have to say?"

"Nothing. He wasn't home. That's why I went tonight."

"You're going to tell me something I don't think I want to hear, aren't you?"

"I blew up his house."

I paused for a moment to digest what I'd heard. "With explosives?" I asked.

"Anton got them for me," she replied. "His dishonor demanded no less."

"You know, there's learning to be human and there's learning to be inhuman," I said. "I realize it must be difficult for you. I mean you woke up a week ago Tuesday with all your brain cells suddenly connected for the first time in your life and decided that you were going to stand the world on its head before the end of the month. But mindless destruction is not a good first step. Do you really want to be the kind of woman who goes around blowing things up because her boyfriend made her unhappy?"

"No," she said, shaking her head and sending her hair shimmering in long cascades. "I just want people to *think* that I'm the kind of woman who goes around blowing things up because her boyfriend made her unhappy. Even if I'm not. For now, that is necessary. Later, maybe not. And then I will want people to think something else."

I rolled my virtual eyes. Life with Penelope was not going to be easy. But it was not going to be boring. ■

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Science Fact

Nanotech Rocket Fuel

Stephen L. Gillett, Ph.D.

A new rocket fuel. An SF cliché, right? Something right out of the Golden Age. And a *nanotech* rocket fuel could only be something devised by a clueless wannabe writer, no doubt with minimal scientific background, who's just trying to inflate their prose with the latest techie buzzword. After all, not only are all the possible fuel-oxidizer combinations now explored, but we now even have conceptual alternatives to rockets, things like skystalks and laser launching, which would be much more efficient. The problem with a rocket is that most of its energy goes into accelerating fuel that's then consumed in its turn. That's a fundamental flaw that no new fuel would solve.

Rocket fuel? Gimme a break!

Except that there just might be something to it. There's always going to be a place for rockets. Whatever their other advantages, things like skystalks and laser launchers require a lot of infrastructure on the ground. Rockets don't (or at least, they don't *have* to—look at all that Golden Age SF again!). And, for safety reasons, *chemically* fueled rockets are going to be the only alternative for transportation off a habitable planet for the foreseeable future.

So it makes sense to make them as efficient as possible. As I described some years back ("The Ozone Rocket," Aug 1985), the traditional measure of rocket efficiency is a parameter called "specific impulse," I_{sp}. Briefly, it's the ratio of the propellant's thrust (i.e., a force) to its propellant flow (which has dimensions of mass per second). Since in traditional (albeit sloppy) engineering practice, mass and force are both measured in pounds[1], the units of specific impulse

[1] Yes, a pound is a unit of *mass*, not just in everyday engineering practice but in law. In 1893 the National Bureau of Standards defined the standard avoirdupois pound as 1/2.20462 kilogram. By a 1959 agreement among the English-speaking nations, the conversion was revised to one pound = 0.45359237 kilos exactly, an adjustment of about one part in ten million. This remains the legal definition of the pound to this day.

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cancel out to seconds. The hydrogen-oxygen combination used in the Space Shuttle Main Engines has an I_{sp} of about 391 seconds. Some higher I_{sp} combinations exist, such as by using fluorine instead of oxygen, but they have *serious* environmental problems. (Or, as with ozone, serious stability problems. Its extra energy comes about because it contains stored energy and wants to decompose spontaneously. That is, it's an *endothermic* compound: It *takes* energy to make. *Much* more on this below.) You could also, in theory, squeeze out a few more seconds of I_{sp} by mixing something light into the hydrogen that reacts even more enthusiastically with oxygen—lithium, for example. That's another notion we'll return to later.

But it turns out other performance metrics can even be more important than I_{sp}. Sure, *ceteris paribus,* you want the highest I_{sp} you can get, but *ceteris* isn't usually *paribus.* You need to also minimize the overhead of the rocket itself: the dead weight of tankage and plumbing that doesn't contribute to payload capacity. Minimizing that burden is harder with some fuels than others. Other things being equal, for example, denser propellants are better, because they need smaller tanks.

The complexity of the plumbing is another source of dead overhead. A conventional liquid-fueled rocket is a *bipropellant* system. It requires two separate, parallel systems for fuel and oxidizer: two sets of pumps and pipes and intricate engineering to bring them all together properly.

Just one propellant would be much simpler. Of course, solid-fueled rockets already do this, all the way from the hobby rocket fueled with gunpowder to the Shuttle's SRBs (Solid Rocket Boosters). In fact, solid-fueled rockets require no plumbing at all—a major mass saving! But we also all know, because of their absence of plumbing, that solid-fueled rockets have the gross disadvantage of not being throttle-able. This is a long-standing problem with the SRBs on the Shuttle. You can't change your mind—you don't even have much control—after they're ignited. Once the candles were lit, the *Challenger,* twenty years ago, was doomed—even if someone had seen the flame leaking from the SRB joint, nothing could have been done about it.

So what we really want is a dense *liquid* monopropellant. Can nanotechnology help us here?

Probably. And in a couple of ways: First, in the synthesis of high-energy molecules whose present syntheses are at best expensive and at worst nonexistent. And second, in the engineering of reasonably stable molecular mixtures of fuel and oxidizer that could act as monopropellants. Indeed these applications are mostly *proto*-nanotech, involving no molecular-level machines or anything like that, so they might even be fairly near term.

Let's look at some of the issues.

The Virtues of Instability

Obviously, the monopropellant must contain stored energy. Lots of stored energy, in fact—as much as possible. In turn, this fundamentally means there has to be a more stable arrangement of the constituent atoms than that in the propellant itself. Obviously, then, there must be big barriers to premature reaction! Nonetheless, monopropellants are intrinsically less safe than bipropellants. They want to "go downhill" and release the excess energy, and we just have to deal with it.

The simplest example of a monopropellant is a mechanical mixture of a fuel and an oxidizer. Ordinary black powder—sulfur, saltpeter (potassium nitrate, KNO_3), and charcoal (carbon)—is the classic example. When black powder ignites, the oxygen in the nitrate oxidizes the carbon and sulfur. And it's well known that gunpowder doesn't take much to set off, even though it doesn't explode spontaneously at ordinary tem-

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peratures. Note, too, that the individual components of gunpowder are perfectly stable by themselves. It's their reaction with each other that makes the explosion.

This is not true for *ammonium* nitrate, NH_4NO_3 or "AN." Like the other nitrates, it's an "ionic salt." The crystal consists of alternating layers of the positively charged ammonium ion (NH_4^+) and the negatively charged nitrate ion (NO_3^-), the whole structure sticking together by its mutual electrostatic attraction. However, there is a difference: The hydrogens in the ammonium ion would really rather be with the oxygens in the nitrate. In other words, the reaction:

(Rxn 1) $2\,NH_4N_3 \longrightarrow 2\,N_2 + 4\,H_2O + O_2 + 237.0$ kilojoules per mole (kJ/mol)[2]

yields energy[3]. Lots of energy, in fact.

The reason AN is pretty inert at ordinary temperatures is simply because it requires a lot of energy input to break down the ammonium and the nitrate so that their hydrogen and oxygen can react with each other. Or, in chem speak, it has large "kinetic barriers" to reaction. In fact, that's what we need for *any* endothermic compound or mixture to be reasonably inert under ordinary conditions. After all, gasoline and air can sit around indefinitely, too: You have to input energy (what a chemist calls the "activation energy") to overcome the reaction barriers.

Like a gasoline/air mixture, AN does react when heated, though, and if really mistreated it can explode. In 1947 much of Texas City, a port on the Gulf Coast near Galveston, was leveled by an enormous explosion when a docked ship containing AN blew up. The ship, with a cargo of some 17 million pounds of NH_4NO_3, had caught fire, and the buildup of heat under sealed hatches caused catastrophic decomposition. Some six hundred people were killed, and the explosion is estimated to have been equivalent to 2-4 kilotons of TNT—quite possibly the largest chemical explosion ever. (Why was the ship carrying so much AN? It's an excellent fertilizer as it contains highly soluble nitrogen in two different chemical states. The cargo was to be shipped to postwar Europe.) Since then, other catastrophic explosions have happened over the years, though fortunately none so devastating. Procedures for dealing with AN safely in ton lots, a direct result of the Texas disaster, have worked well overall.

One thing that made the Texas City explosion worse was that there was additional organic matter present that could be oxidized. The AN was in a mixture that included rosin and paraffin as mechanical binders. Note (Rxn. 1) that there is oxygen left over when AN decomposes completely, and so if there's other material present to oxidize, even more energy is released.

This is the basis for ammonium nitrate-fuel oil (ANFO) explosive: Mix a little fuel oil with the AN and you get a much bigger bang. ANFO among the general public has a horrible reputation because of its use in the 1995 terrorist bombing in Oklahoma City—but as all *Analog* readers know, technology is morally neutral. The same explosive that causes a terrorist atrocity can also dig a mine or a canal.

In fact, ANFO is a very useful, cheap, and *safe* explosive. It is used by the metric ton in mining these days. Nevada gold mines in particular, which are routinely recovering gold present in the ore

[2] I'm using the heat of formation (enthalpy), by the way, rather than the more correct Gibbs free energy. It's a more accessible number, and for these compounds there isn't much difference.

[3] Actually, if you gently heat AN you get nitrous oxide, N_2O, instead of N_2 and O_2. That's a common lab-scale preparation.

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at parts-per-million levels, have to bust up *lots* of rock. You mix the ANFO up in real time, in the blast hole on site just before it's used.

Another, similar compound is ammonium perchlorate, NH_4ClO_4 (hereafter "AP"). It's also pretty inert at ordinary temperatures but contains a lot of stored energy, even more than AN:

(Rxn 2) $4\ NH_4ClO_4 \longrightarrow 2\ N_2 + 4\ HCl + 6\ H_2O + 5\ O_2 + 658.4$ kJ/mol

Oxygen and chlorine have even less desire to stay bonded than do oxygen and nitrogen.

For this reason AP is the main ingredient in the fuel for the Shuttle's SRBs. AP decomposition yields even more extra oxygen than does AN (Rxns 1 vs. 2), so you can get extra thrust if you mix in something for the oxygen to oxidize. The SRBs use aluminum metal and organic binders.

Also as with AN, AP's endothermicity has caused some disasters. Most spectacular was the 1988 explosion, which killed two people, at an AP manufacturing plant in Henderson, Nevada, just outside Las Vegas. It was triggered by an accidental fire started by welders. Some eight million pounds of AP ultimately went blooie. The plant was making AP for the Shuttle SRBs under NASA contract, but since NASA was still paying for AP production but was not taking delivery(!), they were stockpiling the AP. (Yeah, government contracts and all that . . .)

Compounds like AN and AP obviously are a big improvement over saltpeter, but it's still a nuisance to add additional fuel materials to make a propellant "cocktail." What about modifying such molecules so that they are "self-contained" with fuel? One way is with "alkylammonium" ions. Basically, you can swap one or more of the hydrogen atoms on the ammonium ion with a short hydrocarbon chain. Even the simplest, though—replacing one of the hydrogens with a methyl (CH_3) group—is a bit too much of a good thing. Now there's extra fuel rather than extra oxygen:

$2\ NCH_3H_3ClO_4 \longrightarrow N_2 + 2\ HCl + 5\ H_2O + CO + CO_2$

Still, the principle is clear. Why hasn't it been used? Presumably because alkylammonium salts are *expensive*, due to their less-than-straightforward syntheses. There are many steps and lots of (unwanted) byproducts that lead to waste and further purification issues.

So let's talk about synthesis issues for a minute.

On Shaking and Baking and Synthesis

A few years back I saw a paper trumpeting the synthesis of some intricate organic compound heretofore known only in an obscure organism—a lichen, as I recall. The synthesis involved about twenty steps, with an utterly abysmal ratio of finished product to input raw materials—the "yield," as organic chemists call it. And even so, the synthesis still required *other* organic reagents as raw materials.

My reaction at the time was, "Aren't we missing something? The lichen started with only CO_2, H_2O, and sunlight!" Organisms are capable of chemical syntheses that put present technology to shame. And the way they do so is an inspiration to would-be nanotechnologists.

Present synthesis techniques are often derided as "shake and bake." Reagents are mixed together and then the statistics of colliding molecules take over. Usually, you get a mixture of possible products, only one of which you want, so then you have to purify the mess to get it out. Then you react it with the next reagent (or set of reagents) and do it all *again*. Lots of the steps, moreover, usually merely involve putting on and taking off "molecular masking tape"—what an organic synthesist calls "protec-

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tive groups," simply clusters of atoms stuck onto the molecular framework to keep parts of it from reacting so that other parts *can* react. It would be better if we could just react the parts of the molecule we wanted, without having to worry about shielding the other parts.

If (say) your yield at each step averages 80%, then if you had 20 steps your total yield is $(0.8)^{20} = 1.15\%$. There's *lots* of room for improvement.

Biology gets much better yields by using highly specific *catalysts* (enzymes), a catalyst being a substance that speeds up the rate of a chemical reaction without undergoing an overall change itself. If a catalyst is good ("selective") enough, it essentially excludes all the other products except the one you want, so that yields can approach 100%.

It's more than just highly specific catalysts, though. Biology uses highly specific synthetic assembly *systems,* in which the product of one reaction is handed off into the next: Consider the sequential molecular assembly of (say) a nucleic acid chain.

So nanotechnological approaches to synthesis will first of all involve highly selective catalysts. That's already happening—catalysts in fact are one of the best examples of proto-nanotechnology (see "Toward a Not-Just-Diamond Age," *Analog,* March 2007). More than this, though: We need assembly *systems,* structured molecular constructs that receive raw reagents and produce the finished molecular product, just as happens in biosystems. Some work has already been done on attaching reagents to substrates, to control the angles at which the incoming molecules can interact. We could even modulate the substrate by (say) applying an electrical charge to it, either to direct molecular assembly using electrostatic attraction/repulsion, or to induce electrochemical reactions.

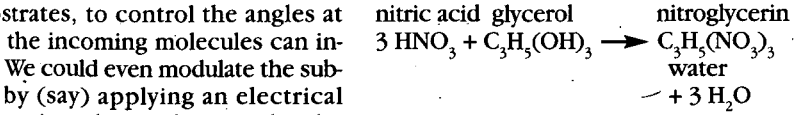
The goal is to produce finished molecules with as little energy expenditure as possible, with as few byproducts as possible, and using the simplest starting materials possible.

Just as the lichen does!

Things That Go Boom

Well, as I've already implied, there's a close connection between rocket monopropellants and explosives. In both cases we're looking for molecules that have a lot of stored energy. In a rocket, of course, we want to release that energy in a highly controlled manner. But often the very same stuff can be used both as a propellant and as an explosive, as we've already seen with gunpowder. With high explosives, though, "detonation"—a catastrophic shock reaction propagating through the substance at speeds of kilometers per second—must be avoided at all costs. At least in some cases proper engineering can keep the reaction rate from running wild like that. (Of course, it's just what we want if we're instead using the compound as an explosive.)

Traditional high explosives are nearly all based on nitrogen-oxygen groups in association with an organic backbone. Just as in AN, the nitrogen acts as a "spacer," keeping the oxygens from reacting with hydrogen (and carbon) elsewhere in the molecule. "Organic nitrates," or *esters,* are made by reacting nitric acid with an OH ("hydroxyl") group on the organic molecule. Nitroglycerin(e), for example, is formed by reaction with glycerin (glycerol)[4]:



And again, the oxygen in the nitrates would *really* rather abandon the nitrogen:

[4] All right, if you want to be *really* formal it's 1,2,3-propanetriol.

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$4\ C_3H_5(NO_3)_3 \longrightarrow 12\ CO_2 + 10\ H_2O + O_2 + 6\ N_2 + 4057.6$ kJ/mol

Boom! (Actually, it wouldn't be that clean; you'd get nitrogen oxides as products, too, which would cut down the overall energy.)

And, it doesn't take much of a nudge to happen. Nitroglycerin is famous for its touchiness. Alfred Nobel, of course, is famous for "taming" nitroglycerin[5] by absorbing it into a porous silica to make dynamite, which is much more stable to handling. (Even so, be careful. Dynamite that's been lying around for a long time tends to be decorated with little beads of "sweated out" nitroglycerin! Old dynamite's a traditional hazard around abandoned mining areas.)

Another nitrate ester is pentaerythritoltetranitrate (PETN), $C(CH_2NO_3)_4$. It's both more powerful and less sensitive than nitroglycerin—though it's still sufficiently sensitive, it's not much used any more.

Nitrocellulose, made by reacting nitric acid with cellulose, is another ester and is sufficiently well behaved that it's the basis for nearly all modern smokeless powders, used as the propellant in firearms. Even so, though, it's easy to blow up even a modern firearm with the wrong formulation. The powder motes are carefully shaped and sized to control the burning rate for different cartridges.

Alternatively, nitric acid can react directly with the carbon backbone, leading to a nitro (NO_2) group directly bonded to a carbon. Trinitrotoluene (TNT, $C_6H_2CH_3(NO_2)_3$) is the most familiar example. It's not very shock sensitive and can even be melted and poured! Obviously this was a great convenience for loading munitions.

The "nitroamine" explosives have a nitro group directly bonded to another nitrogen, rather than to a carbon. RDX (cyclotrimethylenetrinitramine, $(CH_2)_3(NNO_2)_3$) is the "canonical" example. It's a white crystalline solid that's often billed as the "most powerful conventional high explosive," and it's remarkably inert. It merely burns at room temperature and doesn't even detonate when hit with small-arms fire. For this reason it's the main ingredient in plastic explosives. Very probably the reason for its relative inertness is the extra nitrogen "spacer" keeping the oxygens away from the methylene (CH_2) groups.

If you were going to ask about perchlorate esters or perchlorate derivatives, they make nitroglycerin look like a paragon of stability. They're *way* too touchy for practical uses! The perchlorate *ion*, ClO_4^-, at ordinary temperatures is unreactive. It consists of a symmetrical tetrahedron of oxygens with the chlorine stuck in the middle, and its very symmetry makes it difficult to react. Attach something to one of the oxygens, though, as in an ester, and you've got a "handle" for breaking up the tetrahedron much more easily. So far as I know you can't even attach a ClO_3 group (what you'd get by replacing one of the oxygens) directly to a carbon—it just falls apart too fast.

A more fundamental problem with all these sorts of compounds is the dead weight (well, okay, dead "mass") of the nitrogen or chlorine atom. It just acts as a molecular spacer to keep the "fuel" and "oxidizer" parts of the molecule apart. Otherwise, it's a drag on the energy generation and on the specific impulse. The double nitrogen spacers in nitroamine explosives, which probably account for their remarkable inertness, impose even more of an overhead. A further overhead cost is the energy needed

[5] Curiously, tiny amounts of nitroglycerin are used as a drug. Yes, the "nitroglycerin" tablets heart patients take are the very same nitroglycerin—obviously packaged in a nonexplosive way! It's a "vasodilator," meaning that it dilates blood vessels, which is useful for people at risk from strokes or heart attacks.

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to break the bonds so that reaction can even occur.

This is why endothermic compounds and explosives, as a rule, yield lower specific impulse than the simple combustion of bipropellants such as oxygen and fuel. Of course, the rocket pioneers such as Goddard pointed this out nearly a century ago. (And it's also why "fuel-air explosives"—basically aerosols of fuel—are of such interest to the military. Potentially they're much more energetic than ordinary high explosives.)

Again, though, bipropellants have other problems. So let's now look at some different ways to make energetic compounds.

Strains and Bonding

The very chemical bonds themselves provide a way to pack more energy into a molecule. Acetylene (C_2H_2) is a familiar example. Everyone knows it has an exceedingly hot flame, which is why it's used in welding. But *why* does it have such a hot flame?

Because it's an endothermic compound as well, and so the extra energy gets added to the combustion. In fact, acetylene is unstable at modestly high pressure. It tends to react with itself ("polymerize") into a bunch of waxy goo that settles to the bottom of the tank. This is *not* good news if you're expecting gaseous C_2H_2 to come out of the tank to run your welder!

So why is it endothermic? The two carbons are connected by a triple bond, and that bond has higher energy than a single or double bond. (Basically it's holding the carbons too close together, so that their mutual electrostatic repulsion is higher.)

So if we put carbon-carbon triple bonds in something, they will store energy. Compounds based on acetylene are well known: Calcium "carbide," CaC_2, is an example. It's actually an "acetylide," in modern terminology. The two carbon atoms are linked by a triple bond and make up the "acetylide" ion, C_2^{-2}. Formally, the two hydrogens in the acetylene molecule have been replaced by a calcium. An acid is something that releases hydrogen ions, and a "salt" of an acid contains a metal ion that replaces the hydrogen. So we can consider CaC_2 as a calcium salt of acetylene—considered as an acid(!). What, then, about acetylides as high-energy fuels?

One problem is that acetylene's "acidity" is purely formal. In fact, acetylene is so *un*willing to give up its hydrogens that when water is added to CaC_2 acetylene bubbles up. The C_2 ion grabs hydrogen off the water molecules instead! (This is why calcium "carbide" is traditionally used in miners' lamps, by the way. The acetylene from wetting it runs the lamp.) But triple bonds can be put into more complicated compounds—the problem is that conventional syntheses of such things are extremely expensive. (See where the nanotechnology's coming in?)

Strained compounds provide another path to extra energy. Bonds between atoms that result from blending the orbitals from the isolated atoms—so called "covalent" bonds—have definite preferred angles at which they occur. The four single bonds around a carbon atom, for example, define a regular tetrahedron. Sometimes, though, the position of the other atoms in the molecule will not allow the bonds to occur at this preferred angle. Such a distorted bond is strained, and it has higher energy due to that strain.[6]

An excellent and potentially very useful, example of a strained compound is *cubane,* C_8H_8. In cubane the eight carbon atoms occur at the corners of a cube, with the eight hydrogens attached at each corner to fill out each carbon's four bonds. Obviously, the angle from one carbon atom to its three neighbors is 90°. That's what a cube is! This is a far cry from the tetrahedral angle (approximately 117°) that carbon prefers for single bonds. So the bonds are some 27° from where they "want" to be and are

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thus seriously strained. In fact, cubane's heat of formation is some +602 kJ/mol (positive due to the fact that it is an endothermic compound and takes energy to make), and the strain energy is +695 kJ/mol. In other words, cubane is endothermic due to the strain alone.

Furthermore, although the cubane framework is highly endothermic, it's also highly unreactive at ordinary temperatures. As one chemist has put it, it's "thermodynamically a bomb but kinetically a rock." Even at 230-260 °C, some 180 kJ/mol of input energy is required to make it react. Because of this inertness, cubane is even nontoxic(!).

Cubane has high density, too, the highest of any hydrocarbon: 1.29 grams per cubic centimeter. That's almost a third again denser than water! Remember that high density is another desirable feature of a propellant, to minimize tankage mass and bulk.

Quite apart from its possible use in explosives and fuels, cubane derivatives are also potentially of great interest as nanotech building blocks. The problem remains their routine synthesis. The synthesis of cubane itself was a *tour de force*—the molecule had been speculated to be impossible to make simply because of its thermodynamic instability. Even though there's now a lively literature on cubane and its derivatives, they're still extremely complicated and expensive to synthesize.

Which means that they're hardly practical for most applications, particularly when required in tank-car lots!

A Question of Liquidity

We've seen various ways to get endothermic compounds. The problem is that they're not pumpable. Remember? The whole point was to get to a *throttleable* monopropellant. So we need to turn our attention to endothermic *liquids*.

Or more specifically, endothermic liquids that can stand a fair amount of mechanical shock. After all, nitroglycerin is liquid! It's just a wee bit too delicate to be pumped.

We really *should* be able to design a compound that's liquid at room temperature and also has the kinetic stability of (say) RDX, plus much higher stored energy from the incorporation of cubane and/or triple bonds into the hydrocarbon part of the molecule. For example, octa-nitrocubane $C_8(NO_2)_8$, with each corner hydrogen replaced by a nitro group, is estimated to be about 25% more powerful, mass for mass, than other nitrated explosives. (It's been synthesized, but in too small a quantity to test!) It's also thought to be shock insensitive.

And then whatever compound we'd designed we'd need to synthesize. In those tank-car lots.

Alternatively, maybe we could base our propellant system on another substance with a hair-trigger reputation that, however, is probably somewhat undeserved: hydrogen peroxide, H_2O_2. It decomposes spectacularly to steam and oxygen:

$$H_2O_2 \longrightarrow H_2O + 1/2\ O_2 + 54.2\ \text{kJ/mol}.$$

All by itself it's not a bad monopropellant (I_{sp} = 163 sec).

But look at all that lovely oxygen released! Adding some fuel to the mixture

[6] Here's the physical mechanism for the strain energy. A chemical "bond" occurs because, due to the rules of quantum mechanics, the electrons tend to be located between the two atoms that are bonded. The negative electrical charge then tends to "screen" the mutual repulsion of the two atoms so that they stick together. (Since the atoms have given up electrons into the bond, they're left with a residual positive charge.) In a strained molecule this screening is not perfect because the electron density does not lie exactly between the atoms, so the atoms still feel some mutual electrostatic repulsion.

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could (in theory, anyway) really boost the I_{sp} by providing something for the oxygen to oxidize.

Well, let's see. In many ways H_2O_2 is similar to water. Like H_2O, it's a "polar" molecule, meaning it has an uneven distribution of electric charge: The oxygens are slightly negative, while the hydrogens are slightly positive. Polar molecules are good at dissolving ionic substances, such as AN, because the solvent molecules can glom onto the ions with simple electrostatic attraction. (Chemists say "coordinate" rather than "glom," however.) The upshot is that essentially anything that dissolves in water dissolves in H_2O_2 and typically to about the same degree.

So maybe we can dissolve fuel into H_2O_2: alkylammonium ions, for example. One problem, though, is that most oxidizable things you can dissolve react immediately. In fact, concentrated H_2O_2 inflames most organic compounds when spilled on them.

The other problem is that lots of the things that dissolve are excellent catalysts for H_2O_2 breakdown. Many metal ions in particular are highly effective at very low concentrations. They are no doubt responsible for the terrible reputation of concentrated H_2O_2. There have been many accidental explosions involving H_2O_2 over the years. I've been told, though, that if the tankage and plumbing is kept scrupulously free of such contaminants, H_2O_2 can be handled with little more fuss than water.

So what we really have here is the "molecular barrier" problem again. We need to shield the H_2O_2 molecules from the fuel until all is ready.

Now let's think about soap and detergents—"surfactants," technically. Not as cleaning agents—as a way to make dispersed nanodrops of fuel. Surfactants have a long hydrocarbon tail and a "head" of some molecular group that likes to dissolve in water. In ordinary soaps that "hydrophilic" ("water-loving") end is a carboxylic group, COO^-. Because of its negative charge it likes water, while the hydrocarbon tail . . . well, it acts like a hydrocarbon. Oil and water are legendary for not mixing, after all. So soap molecules, when they find themselves in a water environment, try to arrange themselves so that their ionic heads are in the water and their hydrocarbon tails away from it. One thing they can do is form a film on the surface of the water, their hydrophilic heads poking into the water and their hydrocarbon tails sticking up into the air. Indeed, it's not hard to make surfactant films a molecule thick—an almost laughably low-tech approach to nanometer-scale structuring[7].

Or the surfactants can make little balls—"micelles"—*within* the solvent whose outer surface is formed by the hydrophilic heads, while all the hydrocarbon tails poke into the interior of the ball. This is how soaps and detergents work as cleaning agents—oily matter on the object to be cleaned ends up encapsulated in micelles and so can be washed away. A dispersion of micelles in an aqueous (or similar) solution is called an "emulsion," by the way. They're vastly important both biologically and technologically.

So what about dispersing fuel into H_2O_2 as an emulsion? We could even make the emulsion out of a high-tech, rocket-fuel surfactant, with its hydrocarbon tail containing triple bonds or cubane blocks or other energy-rich molecular groups.

One problem is the hydrophilic group, which is on the outside of the micelles and thus in direct contact with the H_2O_2. Obviously it mustn't react with H_2O_2. This rules out ordinary soaps, as their carboxylic heads *would* react easily.

[7] And yes, surfactants are getting a *lot* of attention as approaches to nanoscale fabrication.

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Detergents provide an alternative. Most detergents have a *sulfur*-oxygen group instead as the hydrophilic head—either a sulfate ester, such as the sodium laurel sulfate found in many shampoos, or a sulfonate, like the alkylbenzene sulfonates used in many detergents. (In sulfate esters, the sulfur atom is hooked to the hydrocarbon chain through an oxygen link; in sulfonates, sulfur is directly bonded to carbon.) Of course, in such cases sulfur would be another "deadweight spacer" atom, as it wouldn't contribute to the energy of the combustion, but since it's a small part of the overall molecular mass that probably isn't a big problem.

A bigger problem is mixing the emulsion into the H_2O_2 in the first place without everything blowing up! Once the micelles are established they should be stable, but making them in the first place is a challenge. In water, you simply disperse the surfactant and the micelles form automatically, via self-assembly[8]. That won't work in H_2O_2—the hydrocarbon "tails" will have lots of time to react before they can get tucked into the micelles. Somehow the micelles are going to have to be made elsewhere (in an aqueous solution?) and injected into the H_2O_2.

So we need yet more nanoengineering . . .

Conclusion

Of course, better catalysts, nanoscale synthesis, and so on will have vastly more applications than just high-tech rocket fuel. So there are lots of other economic incentives to develop them—which is good, as I don't see rocket fuel as being nearly enough incentive by itself! It also means we probably don't need a Dedicated NASA Program or some such boondoggle.

Perhaps, in fact, all those old stories about the dedicated, eccentric inventor devising a new fuel in his back yard, with or without the assistance of his trusty sidekick and beautiful daughter, may not be so far off the mark after all. . . . ■

[8] *Another* set of techniques that's getting lots of attention for nanoscale fabrication.

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A Bridge in Time

Joseph P. Martino

Wherein "detour" takes on a whole new meaning. . . .

The phone rang. He picked it up.

"Maintenance. Carson speaking."

"Tom, this is Sandy."

"Yeah, boss, what's up?"

"The grocery job finished?"

"Yeah. There was a bad module in the controller. I swapped it out. When I left, they were getting a shipment of fresh-picked apples from next October."

"Thanks for the tip. I'll stop and get some on the way home. Be sure to send the module to the lab. We need to find out what went wrong."

"Done already, boss."

"Good. Got another job for you."

"What this time? Another warehouse?"

"No. This is out on Highway 297, about ten miles west of town."

"What's the problem there?"

"I don't have details. We just got a call. We have two units at a bridge out there. I figured you'd be the best guy to tackle it."

"Thanks for the confidence, boss. I'm on my way."

Highway 297 turned out to be a two-lane rural road that twisted and turned through alternate farm and woods. Carson finally reached a bridge.

This must be the place, he thought.

There was a sign beside the road:

BRIDGE CLOSED NIGHTLY 1 AM TO 2 AM.

Beyond the sign he could see one of the company's time gates, both doors raised so cars could drive right through. At the other end of the bridge another gate was visible, its doors also open.

A knot of people stood near the bridge ramp. He pulled off the road near the fence that blocked anyone from bypassing the time gates, and approached them.

A guy in a hard hat, he thought. *Must be the construction foreman. A guy in a Highway Patrol uniform. A guy in plain clothes, who has "cop"*

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written all over him. FBI maybe?

As he approached, he introduced himself. "I'm Tom Carson, with the Maintenance Division of Time Gates. You have some kind of a problem here?"

The man in plain clothes said, "I'm FBI Special Agent Arthur Hamilton, with the Time Crime Division."

Bingo!

FBI held up a copy of the *Wall Street Journal*, folded so only the date was visible. The date was for three months ahead.

Hardhat chimed in. "We inspect the bridge every morning. One of my guys found this newspaper. We called the highway patrol."

The trooper spoke up. "The bridge is under our jurisdiction, but Time Crime isn't, so we called the FBI."

"And we called your company," FBI added, "because there may be a flaw in your equipment."

"Look," Carson said, "I'm used to working with time gates in warehouses. What's going on here?"

Hardhat spoke up. "Starting in just over two months, this bridge'll be closed. We'll tear it down and replace it. It's scheduled to be reopened eight months after that. We're trying something new. Instead of detouring people all over hell's half acre while the bridge is out, we're using your time gates. We shunt people down-time from when the bridge is out, let them cross here while the bridge is temporarily closed, then shunt them back up-time to where they came from. If it works here, we'll use it on bridges with more traffic."

"So that's why you're closing this bridge in the wee hours every morning?"

"You got it."

"But why not shunt them up-time, to when the new bridge is in?"

"This way we know the bridge is here," Hardhat answered. "We can't be sure when the new bridge will be open. Might be construction delays. A flash flood might wipe out the bridge."

"Or terrorists might blow it up," FBI added, "like they tried to do with that bridge up on I-70."

"But can't the highway department send back messages every day, confirming that the bridge is open?"

FBI frowned and shook his head. "Besides being illegal, it's a bad idea. With all that message traffic, no one could scan it all. It'd be too easy for someone to slip in something illegal. Stock prices. Horse race winners. Basketball scores. You name it."

"But groceries send messages all the time," Carson protested.

"Not the same," FBI said. "They don't use the time gates for messages. They place an order for future delivery, specifying a time and date. If it's a regular order, the supplier loads it on a truck. If it's for an out-of-season product, the supplier sends it through a time gate. No message traffic either up-time or down-time through the time gate."

"Okay, I see what's going on. But how do you protect against criminal activity here?"

Hardhat said, "We photograph every car, including the license plate, when it enters the time gate up-time. A computer stores the picture, along with the time and date it entered the up-time gate, and the time and date it was shunted to the bridge here. We take another picture here of every car that arrives from up-time, storing time and date. And likewise for when the car crosses the bridge and is shunted back up-time. Eventually we can match the records from now and up-time, if there's any questions."

"Do you video the car as it crosses the bridge?"

"No. Just a single photo."

"Then any of the cars could drop something off while they're crossing the bridge, couldn't they? And you wouldn't know it?"

Hardhat and FBI looked at each other.

"Looks like we have a hole in security," FBI finally said.

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"I'll have somebody check the bridge at two A.M. every morning," Hardhat finally said.

"Okay," FBI said, "but if anything more happens, we may need additional security."

"Right now," Carson said, "I'll check both units, just in case something's wrong with them. But I think your problem is with the traffic, not with my equipment."

The dew lay heavy on the grass. The sun, half a diameter above the horizon, shone red through the morning haze. Ahead of Carson, the crushed stone jogging track curved around some trees.

Carson held his head high, sucking huge drafts of cool morning air deep into his lungs. He was into his second mile. He had his second wind, his legs were swinging as regularly as a metronome, and endorphins were flooding his bloodstream. He felt on top of the world.

As he leaned into the turn, another runner, a woman, came out of a side trail. Her long blond ponytail swung in time with her pace.

Nice legs under those running shorts, he thought. *And she's obviously got a jogging bra under that tank top.*

The woman dropped back and fell in step with him.

"Mind if I run with you?" she asked. "I do better when I have someone pacing me."

"Not at all."

They ran in silence for a while, then between breaths she asked, "How far are you going?"

"Just over three more miles. That'll make five for me."

"Okay, I can stay with you that far. I usually stop at four miles."

"You ought to try for five some day."

"I'd either have to start earlier or be late for work."

"What's your job?"

"I'm a stock analyst. And yours?"

"Maintenance engineer for Time Gates, Inc."

"That sounds interesting. But engineering was always beyond me. I was good at numbers, but not at things."

They continued in silence until they finally reached the bathhouse.

The woman untied her ponytail and shook her head. Her hair cascaded down below her shoulder blades. "Time for a shower and then off to work," she said. "Thanks for letting me run with you. The woman I've been running with was transferred out of town, and I've missed having someone to pace me."

He paused a moment, then said, "You want to try for five miles tomorrow?"

She cocked her head to one side, then said, "Okay, I will. By the way, I'm Jennifer Campbell." She held out her hand.

He shook her hand. "I'm Tom Carson. I start running at five thirty."

"Good. I'll see you then."

As Carson arrived at the bridge, Hardhat and FBI were already there.

"I got your call," Carson said. "What's up?"

"We caught the guy who was throwing out newspapers," FBI said. "We've had the place staked out the past three nights. Last night a car came through. It slowed in the middle of the bridge. The driver threw a copy of the *Wall Street Journal* over the side of the bridge. This time it went down into the ravine.

"There was a guy standing down there waiting for it. We caught him with the paper in his hands. We checked the license on the car. It's registered to the same guy who caught the paper. He was passing information down-time to himself. Open and shut case of time crime."

"So what'll happen to him?" Carson asked.

"Depends on whether he accepts a plea bargain," FBI replied. "Minimum of five years in jail. Up to twenty-five years if he goes to trial."

"But if he's in jail, how can he throw a paper to himself?" Hardhat asked. "And if he doesn't throw a paper to himself,

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what's he guilty of?"

"Look," Carson said. "Don't ask me to explain time travel paradoxes. All I do is fix the time gates when something goes wrong. Paradoxes are argued over at a much higher pay grade than mine."

"Doesn't matter," FBI said. "The crime's already been committed when he receives information from up-time. Even if he can no longer send it to himself. Anyway," he turned to Carson, "we're going to put nets on the sides of the bridge, so this can't happen again. We called you out here to make sure that whatever we do with the nets doesn't interfere with your time gates. Can you check that?"

"Sure. I have my instruments with me. Put up your nets and I'll run a set of diagnostics on the time gates."

It took Carson three days to muster enough nerve to ask Jennifer for a date. As he picked her up at her apartment he asked, "Any preferences? Chinese? Mexican? Italian?"

She smiled. "Italian sounds good. I had egg rolls for lunch anyway."

"Fine. Franco's, down on Fifth Street, is one of my favorite places."

After they had placed their orders, Carson said, "You told me you were a stock analyst. Just what's that?"

"I work for Consolidated Insurance. We underwrite almost any kind of insurance. Life, auto, fire, and so on."

"What's that got to do with stocks?"

"The premiums our policy holders pay don't fully cover the losses we have to pay out. Instead, we invest the policyholders' money in stocks and bonds. The income from that allows us to reduce the premiums below the true actuarial value."

"Hmmm. I never thought about that. I just figured I paid money in, and if I had an accident or a fire I got some of it back."

"That's only partly true. You'd be paying in more if we didn't invest your money well. But what do you do with time gates?"

"Fix them when they go wrong."

"Does that happen often?"

"It doesn't happen often. Our failure rate isn't as low as, say, airliner jet engines, but it's much lower than that of the telephone system."

"What happens if someone gets caught going through a gate when something goes wrong?"

"That hasn't happened yet. We haven't lost even a shipment of apples, let alone a person. There are enough interlocks and safeties that if something does go wrong, the gates are supposed to shut down rather than shunt anything through." He rapped his knuckles on the tabletop. "I hope they always work."

"This bridge-out thing you're working on. Doesn't that mean that somebody is in two places a once? Home, say, and also in a car on that bridge?"

"To my simple mind, it does. However, the quantum mechanics guys say all the atoms in the two people are in different states, so they're not really the same person. Same thing with cars or anything else."

He described the incident involving the *Wall Street Journal*. "There was a case where a guy was on the bridge and down below it at the same time. All I can say is, it seems to work."

"But what about conservation of matter? Say you send a shipment of apples back from October to August. Those same apples are on the tree and in the grocery at the same time. Where'd the additional matter come from?"

"That one's simple. Even I understand that one. The apples go through a closed loop. They appear to be in two places at once, only from August through October. Once the apples on the tree reach October, they're picked and shunted down-time. Before August, and after October, there's only one set of apples. I guess it means the law of conservation of matter has to be extended to allow for time travel."

Their orders arrived. They shuffled

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things around on the table to make room. Between bites, Jennifer asked, "What else are they doing on that bridge, besides putting up nets?"

"They've installed video cameras. Now they have a video record of a car for the full time it's on the bridge."

"So if anyone throws anything out or drops anything, they'll spot that?"

"That's the idea. I know they have lights on the bridge now so the video cameras have a good view of everything."

"Sounds like it's pretty expensive."

"I guess it is, but they tell me it's still better than detouring cars around the bridge. They must know what they're doing." He paused. "Well, maybe not. It's the government. Probably doesn't matter to them whether it's good economics or not."

"Why do they go to the trouble of checking on people anyway? Suppose somebody does send back a newspaper. What harm is done?"

"Well, the way it's been explained to me, letting people transmit information down-time encourages the wrong thing. For instance, what do you do in your stock analysis?"

"Well," she replied, "I look at an industry. Is it profitable? Is it likely to decline? Then if the industry looks good, I look at individual firms in that industry. Which firms are well placed to be more profitable than average? If I find a good prospect, I recommend investing in it."

"Okay, that's the point. You use rationality, logic, and so on, to try to make good decisions. Suppose someone bypassed all that by being able to read next month's stock market news. In effect, that's cheating. It's like reading the answer in the back of the book instead of working the problem. You don't learn anything. Instead of rewarding intelligence and effort, allowing people to profit by sending information down-time rewards chicanery. That's why it's a crime. As the FBI guy told me, we want to encourage brains, talent, and hard work, not skullduggery."

"It sounds good, but I wonder if they catch all the 'cheaters,' as you call them."

"Beats me. The FBI guy that's working on the bridge seems pretty sharp. He's mentioned several cases where he's caught people involved in time crime."

"How can they tell if someone is illegally using information from the future, or is simply good at, say, buying the right stocks or picking the right horses?"

"He tells me they almost always have to depend on physical evidence. Somebody simply being right isn't enough. Even if one day somebody correctly picked the winner in every race at the Laurel racetrack, that wouldn't be good enough to convict."

"The odds against that must be incredibly high."

"Yeah, but it's conceivable that the bettor was simply a good judge of horseflesh. They don't want to penalize that. They need something substantial to prove he got the results from himself or someone else up-time.

"However, I imagine that if someone did that, they'd start looking for physical evidence."

"So they insist on physical evidence? That's interesting. I guess I better be able to document all my research into stock values, just in case I get incredibly lucky."

She changed the subject. "How'd you get into the time travel business, anyway?"

"I don't really consider myself that much into it. I got a degree in electronics engineering. My first job out of college was repairing radio station equipment for a broadcast chain. After a while it got boring. I looked for another job, and ended up with Time Gates. I don't deal with the theory. I just fix the electronics. It pays well and it's challenging work, but I leave the job behind me at five. Most nights and weekends, I don't have to think about work."

"Well, I hope my questions haven't

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bothered you. I'm just curious about something that sounds so strange."

"Not at all. I guess I don't very often get a chance to talk about my work. I'm glad you were interested."

He called for the check, and they left the restaurant. As he dropped her off at her apartment he said, "Tomorrow morning again?"

"Yes. Maybe I'll think of more questions for you."

"I'll try to answer them."

Carson parked his car near the bridge. As he was examining the readouts on one of the time gates, Hardhat walked up.

"Something wrong?"

"Nope. Just a routine check. I try to check all the time gates I'm responsible for once a week."

"How often do you find a problem in a routine check?"

"Only one complete failure in the two years I've been at it. The other guys tell me their experience is about the same. Actual failures are rare. Incipient failures, though, are a little more frequent. We can use diagnostic tests to catch something that's getting weak and replace it before it fails."

"Sounds like the same thing we do. Look for cracks in bridges to catch them while they're still small. Acoustic checks to find hidden flaws before they get big. Saves a lot of trouble later."

"Anything more from that FBI guy?" Carson asked.

"He shows up every couple of days, but there's been nothing since they caught that guy with the newspaper."

"Hope that means there aren't any more people trying to get an unfair edge on their competitors. Every time there's a scandal like that some politician gets headlines by calling for more regulations on us."

"Well, up to now any funny business here has been on the receiving end, like that guy catching a newspaper. Three more days and we close the bridge. Then any funny business will be on the sending end."

Carson's relationship with Jennifer had steadily deepened. In addition to their morning runs, they went out two or three times a week. They found they had many interests in common. From dinners, they added movies, plays, and museums to their outings, and tonight, a symphony concert.

As Carson adjusted his necktie, he thought, *This thing with Jenny is getting serious. I'm falling in love with her. But I don't know how she feels. She must like going out with me, but is that all it is? Sure wish I knew how this thing was going to turn out. Maybe it's better I don't know. But I'd sure be tempted to send myself a warning message through a time gate if things turned out badly.*

As they sat eating before the concert, Jennifer asked, "When somebody crosses that bridge, how do you make sure they get back to the same time they left?"

"Ever listen to what goes on when you send a fax? You hear the dialing sound, then the whistle from the other machine, and the growl from your own machine?"

"I've never paid it much attention, but yes, I remember those noises."

"Well, that's called a 'handshake.' There's a protocol that both machines have to follow to make sure the fax goes through.

"Well, there's a handshake protocol for the time gates, too. In the usual case, the sending time gate establishes a connection with the receiving gate and verifies the connection is correct before anything is sent.

"On the bridge, it's a little more elaborate. There's an infrared link between the gates at the two ends of the bridge. When a car enters a gate, the gate establishes a connection with itself downtime. It also sends a signal to the gate at the other end of the bridge. That gate es-

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tablishes a connection with itself at the same day and time as the first gate. Nothing happens until both links are established. Then the car is shunted down-time. When it crosses the bridge, the gate at the other end is already set up to return it to the same day and time as it departed.

"If there were anything wrong with either connection, the car wouldn't leave the first gate. It's as safe as we know how to make it."

"How do you make sure there aren't two cars on the bridge at the same time?"

"The bridge has been closed for an hour each night. We divide that hour into two-minute time slots. For the three months the time gates have been operating, that's roughly twenty-seven hundred time slots. That's about twice the number of time slots actually needed, based on traffic counts before the time gates were installed.

"Cars get assigned to time slots at random, except that we keep track, so no two cars are assigned the same time slot."

"What if a car takes more than two minutes to cross?"

"We count two time slots as having been used up."

"It sounds like you've taken care of everything."

I hope we have, he thought, *but I'm still waiting for the day Murphy catches up with us. Hope that's after I'm safely retired.*

As they finished eating, he called for the check and they left for the concert hall.

"So," Carson said, "this is the day the bridge comes down?"

"Actually it will take a couple of days," Hardhat said. "Wrecking ball, jackhammers, and finally cutting torches on the steel members. It'll come down, but a piece at a time. Nothing worth watching. It's not like watching them implode a building."

"Guess there won't be much to see, then," Carson replied. "Still, I need to make sure nothing happens to the time gates."

He turned to FBI. "What will you be doing now? Staking out the bridge to watch cars crossing?"

"No," FBI replied, "we won't need to do much now. We've made sure nothing physical was received down-time, so we're pretty sure nothing was sent. However, we'll be sorting through all the pictures we took, to see if there are any patterns. Same car repeatedly going through, even though the driver doesn't live around here, things like that."

"Sounds pretty dull."

"It is, but that's the way we catch crooks. Watch for the little things they don't think of, that give them away."

At dinner that night, Jennifer said, "We're starting a big project at work. Computerizing a lot of data. I'll be tied up weekday evenings for the next several months. No more dates during the week, I'm afraid, but I'd still like to see you on weekends. I hope that doesn't disappoint you."

Disappoint me, yes, he thought, *but there's definitely a bright side. She does want to see me even if it can't be on weeknights.*

"And of course I'll still be running every morning," she went on. "So it's not like we won't be seeing each other except on weekends."

"I'm glad of that," he replied. "I really enjoy your company, and I'd miss you if, say, your company transferred you."

"Not likely," she said. "The kind of work I do is all done at headquarters. There's really no place else they could send me. So there's no reason you'd have to miss me."

I don't want to ruin things by getting too eager, he thought, *but it sounds like I won't be tempted to send myself any warning messages.*

Carson closed and latched the access

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hatch.

"There. Got the weak part replaced before you had an in-service failure. Sorry it took so long, though. The fault was hard to trace."

"Good," the warehouseman replied. "We'll be getting a lot of Christmas stuff through soon. Wouldn't want a failure then. It really helps to know what the big sellers were, so we can order them and have them made next year, then have them shipped down-time to when the customers want them."

"Cuts out a lot of after-Christmas sales, though, doesn't it?" Carson asked.

"Yeah, but it means we don't have to sell things at a loss after Christmas. We can price them without having to worry about eating the cost of a lot of unsold stuff. It averages out. We get a better profit, and the customers get a better price."

The sun was already down as Carson crossed the parking lot to the company car he was using. *Too bad I don't get overtime for jobs like this*, he thought. *But it doesn't happen very often.*

He headed back to Time Gates to pick up his own car. The route took him past the apartment complex where Jennifer lived.

Wonder what she's doing this evening. They must have a lot of data to computerize if it's going to take several months.

A car pulled out ahead of him.

That's Jennifer's car! Where's she going?

He hung back, so she wouldn't feel as though she was being followed, but he kept her car in sight. Finally, she turned off.

That's route 297. Is she heading for the bridge?

He turned and followed her, while maintaining a discreet distance. She continued to the bridge. He saw her car enter the time gate and disappear, then appear again on the other side of the gap.

Why'd she do that? Was that why she asked me all those questions about safety? Did she know she was going to cross that bridge and want my reassurance? Just what's going on here?

He had pulled his car off the road and turned around. Just as he was about to start back, Jennifer's car appeared again. He followed her to where she turned off to go to her apartment. He turned the other way, dropped off the company car, and drove back to his apartment.

Once inside, he paced back and forth.

She made it clear she wanted to see me on weekends. Why'd she tell me about a big project at work that'd keep her busy weeknights, when she's really going back and forth across that bridge? Or is crossing that bridge part of the work she claims she's doing?

He sat down and held his head in his hands.

Blast! This really makes me feel sick. He thought back to their first date. *She asked me about the bridge job, but I never told her I was working on that. Somehow she already knew. And she told me she was good at numbers but not at things. Yet she asked me about conservation of matter. Somehow that doesn't add up.*

He started pacing again.

Is she sending financial information back to herself? That would fit in with her job. But if so, how's she doing it?

FBI was sure no physical evidence had been sent back, once they put up that net. What he really meant was tangible evidence. Something you can see and feel. But physical doesn't have to mean tangible. Radio waves are physical, but not tangible. Could she have been sending a radio message to herself? Or to someone else?

Should I go to FBI with my suspicions? Not a good idea. If she's innocent, I don't want them paying attention to her. And what would she think if I told them I thought she was involved in time crime? That would really put an end to our relationship. No, I'd better check up myself. If I find something, then it's time to bring in Mr. FBI.

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* * *

He'd rented a car, so Jennifer wouldn't recognize it, then waited outside her apartment. After dark she came out, got in her car, and drove off. He followed at a discreet distance, tracking the transmitter he'd stuck under her car the previous weekend.

She drove through the time gates, turned around and came back. Once she was gone, he parked near the time gates and got out his instruments. He checked the two time slots to which her car had been shunted, going and coming. He adjusted the equipment to send him to a time slot a few minutes before her first passage. He stopped in the middle of the bridge and hung a broadband receiver on the netting strung on the near side. Once back to his own time, but on the far side of the bridge, he adjusted the time gate to shunt him to a vacant time slot a few minutes after her first passage and retrieved the receiver. He repeated the process with a second receiver for her passage back, then headed for his apartment.

The sour taste of vomit was still in his mouth. He'd emptied his stomach, but still felt as though someone had kicked him in the gut. He sat down and shook his head.

No question about it. The receiver recorded a burst transmission from when her car passed over the bridge the first time. Nothing on the second, but that doesn't mean anything. She's sending information to somebody. No help for it. I've got to go to FBI.

The phone wakened him from a restless sleep. He blinked the grit from his eyes and grabbed the handset.

"This is Arthur Hamilton, FBI. I need to talk to you."

"Good," Carson said, more harshly than he intended. "I need to talk to you, too."

He parked outside the Federal Building and went to Hamilton's office. Hamilton waved him to a chair in front of his desk.

"Good morning, Mr. Carson. We have pictures of something that needs explaining.

"I've been going through the videos from that bridge. We found one with a car that stopped in the middle of the bridge and apparently hung something on the netting we'd put up. A few minutes later the same car came back and retrieved whatever it was.

"We identified the car as a rental car, and we determined that it was shunted down-time from last night. It seems that it was rented to you last night. Can you explain that?"

"Yes, although what I have to say hurts like hell to say it."

He brought out the two receivers and placed them on FBI's desk.

"I don't know which night your video showed, but there's a second one, too. These are the things you saw me hanging on the net and picking up a few minutes later.

"I suspected that the woman I've been dating was sending information down-time to someone. I didn't want to say anything to you unless I had proof. Well, I have it.

"I tracked her car to the bridge, found the time it had been shunted back to, then contrived to have myself shunted back to a time just before that. I hung one of those receivers on the net, then went back to a time just a few minutes after she passed through, and collected the receiver.

"She was using burst transmission to send a whole lot of information in a short time. It's encrypted, so I couldn't read it. However, she was obviously sending something to somebody. My guess is it was financial information. It really kills me to do it, but I don't have any choice. I have to turn her in to you."

He sat back in the chair and waited. Finally Hamilton spoke.

"Sleuthing is a bit out of your line, isn't it? You should have come to us right

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away."

"And suppose I'd been wrong? I'd have brought the woman I loved under suspicion, unnecessarily. I figured if the receivers didn't pick up anything, she was clear."

"Well, you did it and you know. But one thing first. Are you sure those transmissions came from her? Were there other cars that came through between the times you placed the receivers and retrieved them?"

"Don't try to give me false hope. Of course there were a few other cars. Two or three, anyway. I picked time slots as close to hers as I could get, but some closer ones were already taken. But look at the time the burst was recorded. It matches the time slot when she went through, not when someone else went through."

"Very well, we'll look into it. If she's done this several times, we'll check on each time. Also, we'll have to rule out the possibility the burst came from off the bridge, not from any car.

"She may not be the only one doing it; too. She may have fellow conspirators. What's more, now that you've showed us a new way for someone to commit time crime, we need to look for other conspiracies as well."

He held up the receivers. "You built these yourself? They look professionally done."

There was a sharp edge in Carson's reply. "I am a professional."

"Yes, of course. Now, are you planning to go to work today?"

"No. I wouldn't trust myself to do the job right. I'm going to call in sick. It won't be a lie, either."

"You do that. But one bit of advice. Don't try to drown the pain in booze. That only puts off the pain and makes it worse when it finally comes."

"Are you speaking from experience?"

"I ask the questions, Mr. Carson. But take my word for it. Trying to drown your sorrows in booze drowns you, not the sorrows."

Two days later the headlines read:

CONSOLIDATED INSURANCE EXECUTIVES ARRESTED FOR TIME CRIME

They sure moved fast, Carson thought. *Wonder if they got a confession out of somebody. And what about Jenny? Was she one of those arrested? I could call her, but I really don't want to find out.*

A week later Carson got a call from Hamilton.

"Come down to the Federal Building. Meet me at the Grand Jury room on the fifth floor."

He found a parking place near the Federal Building.

Public servants have tax-paid parking spaces, he groused, *but we taxpayers have to pay for our own, even when we're dealing with our rulers.*

Hamilton was waiting for him outside the Grand Jury room.

"The jury returned indictments on about half of Consolidated's executives," he said. "The conspiracy was pretty big. Most of them are going away for a long time."

"What about Jenny?"

"She's a cooperating witness."

"Yeah, I know what that means. You threaten to throw the book at them, so they plead guilty, whether they are or not, and they agree to testify against the others, whether they really know anything or not."

"She was guilty and you know it. However, she was only one of the small fry. In return for her testimony against the big fish, the prosecutor has agreed that he'll ask the judge to sentence her to only a year. The people on top will get twenty-five."

"Okay, why'd you call me here?"

"Miss Campbell wanted to see you."

Hamilton opened the jury room door. Jennifer stepped out. At the first sight of her, Carson's heart kicked him in the ribs. He gasped for breath.

Even that baggy orange jump suit

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can't completely hide her figure, he thought. *But they've hacked off her hair. Now it just frames her face. It'd look good if it'd been done by a good hairdresser instead of a prison barber.*

A bitter smile crossed his face as he recalled his fantasy of spreading Jennifer's long blond hair on a black satin pillow. *That'll never happen now.*

She stopped about six feet in front of him.

"Tom, I'm sorry. I was assigned to cultivate you and pick your brains about the security measures at the bridge. At the time, it didn't seem like a big deal. What I didn't expect . . ." she paused, took a deep breath, and blurted out, "What I didn't expect was that I'd fall in love with you."

She took another breath.

"I've hurt you, and I've hurt me, and I've messed up something that could have been good. I hope you can forgive me."

Without waiting for an answer, she turned and walked toward the waiting guard.

"Does she know," Carson asked, "that I'm the one who intercepted her transmissions?"

"No, we kept you out of it. Once we knew what to do, it took us only a day to get an iron-clad case against her."

"Don't you tell her. I figure she has a right to hear it from me."

Hamilton gave Carson a long, piercing look. "Are you sure you can trust a woman who'd betray you the way she did?"

Carson sighed, then said, "I guess I've got a year to find out, don't I?" ■

Be not simply good; be good for something.

—Henry David Thoreau

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BIOLOG Richard A. Lovett

Ekaterina Sedia

Ekaterina Sedia likes lichens. "They're like little trees," she says. That's because she's a biologist who did her Ph.D. studying them in New Jersey's Pine Barrens.

To date, however, there haven't been any lichens in her *Analog* stories. Instead, they've been about genetic engineering, including the popular "Alphabet Angels," which (coauthored with David Bartell) not only won an AnLab Award, but was her first-ever fiction sale.

That story appeared in 2005. Since then, she's only appeared a handful of times in these pages, but she's published two novels and racked up nearly two dozen short story sales to other publications.

And she's not even doing this in her native language. Sedia was born in Russia and didn't move to the U.S. until 1991. Nor did she grow up reading science fiction. She began with literary mainstream, then shifted when she got older, "because there's just so much realism you can take."

She found that science fiction and fantasy are still basically about the human condition. "But you can put those humans into more interesting situations."

One advantage of coming to the field late was that she'd developed a literary taste that she could import into her fiction. "Words matter," she says. "Style isn't something separate from a story."

As a biologist, she's struck by the paucity of stories featuring good, plausible biology. "Genetic engineering is generally used like magic," she says. "It's the same with nanotechnology. Most people don't see the limitations."

She also likes history. An upcoming novel, *The Secret History of Moscow,* (due in November) deals with the things every culture sweeps under the carpet. "Basically, it's history written by the losers," she says.

As a Russian, she's sometimes drawn to darker-than-average stories. "It's a stereotype," she says, "but accurate." Nor is she a fan of technological fixes. Many problems, she believes, are unintended consequences of prior technologies.

She avoids the pretense of thinking she writes only to entertain. Entertainment is important to her, but it can't be the only thing. "I recently saw magazine guidelines that said, 'No agenda stories,'" she says. "All stories are agenda stories. You might not necessarily notice the agenda, but it's there. Either it's maintaining the status quo, or challenging it, or approving it, or ignoring it. For me, it's about acknowledging and questioning the status quo." ■

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Virus Changes Skin

Ekaterina Sedia

The question "Who's in charge here?" may apply on very large scales. . . .

Willow Robertson smoothed the skirt over her thighs and perched on the examination table. Her hands gripped the edge, and she spent some time studying them—pale, with the slightest yellow tinge. Like nicotine. Jaundice. Old T-shirt.

She chased the thought away and instead rehearsed her words for Dr. Margulis. She arranged them carefully in her mind, fearful that the moment she started talking they would scatter like pearls, the string of resolve that tied them together broken.

She looked out of the window at what used to be tundra just a few decades back and now became the pale scrub of pines and oaks. The sun beat down on the tarmac roads and the haggard town of hastily erected houses, shops, hangars, but people stayed indoors. Not safe. Even the farmers had to work in full protective gear.

Dr. Margulis entered the examination room, and as she walked she flipped through Willow's chart, skimming every childhood hurt (appendectomy at six, a leg broken on the monkey bars at ten), every adolescent embarrassment (laser removal of acne scars at fifteen, corrective eye surgery at seventeen), and every adult self-denial (tubal ligation at twenty-four, breast reduction at twenty-eight).

"What can I do for you?" Dr. Margulis said.

Willow gripped the edge of the table harder, watching the half moons on her nails pale into white. "My mother died last week."

"I am sorry to hear that." Dr. Margulis's face folded along the well-worn lines into a habitual grimace of sympathy. Every doctor Willow had ever seen had that prefab expression, and these days their faces assumed it almost automatically. Too much cancer. Too much sun.

"It's all right," Willow said. "I mean,

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she was in her eighties." And answered the unspoken question, "I was a late child. Anyway, since my parents are gone now, I would like my alterations reversed."

"Your skin?" The doctor did not hide her surprise.

"Yes. And hair. I understand why my parents did it to me, they wanted me to have a better shot at getting ahead, but now I can do what I want. Right?"

"Of course. It's just . . . what are your coworkers going to say?"

Willow shrugged. She did not have an answer to that. People's opinions mattered less to her with each passing year.

"Don't you like being the way you are?"

"I don't hate it," Willow said. "But my parents did not ask me about it. They just had it done. And when I was little, I could not understand why I was a different color than they, and why they wouldn't come to my school plays. And I was angry that they didn't ask me. And they said that they didn't want me to change color when I was grown up—people would wonder, they said. You'd never pass then; someone will always remember that you used to be black."

Dr. Margulis raised her eyebrows and gave a sigh of resignation. I'm not going to argue with that, her demeanor said, I have better things to worry about. "Fine. The receptionist will schedule you for some time next week. I'll prepare your inoculation."

"Oral?"

The doctor nodded. "A very simple one. A single gene that will release the suppressors on your melanin genes."

"And hair," Willow reminded softly.

"And hair. You'll have to shave your head, of course, and your new hair will grow with your original keratin structure. Anything else?"

"How long will it take?"

"For hair, a few weeks. For skin—it will be gradual. As your old cells slough off, the new ones will have a heavy pigmentation. The virus will target the skin cells only." The doctor spoke with obvious pride in her ability to communicate complex information in simple terms.

"Thanks," Willow said. As she was leaving the examination room, she heard Dr. Margulis say, "What are you trying to achieve?"

"I don't know," Willow said and closed the door behind her.

It was true, she didn't. Color did not equal culture, and that was one thing that she had lost and could never reclaim. She still would be a white person, even if her skin turned the deepest shade of sienna. But she owed it to her mother to at least look like her.

Willow was growing impatient—two weeks after she took the viral pill, her skin tone deepened only a little. Still, people noticed. She saw heads turn as she walked from her apartment complex—a new ugly building made even uglier by the massive solar panels on the roof—to work.

"You really shouldn't be out in the sun," Andre, her coworker at the Corn Institute, said. "Skin cancer is no joke."

Willow rolled her eyes. "If you're done stating the obvious, do you mind looking over these data with me?" She spread the sequencer printout on the lab bench and rifled through the reference library of plant genomes. "Does this look right to you?"

Andre tugged on his upper lip. "Nope," he said. "Which strain is it from?"

"IC5. The dwarf."

Andre's face lit up. "I love that strain. They're so *cute*."

Willow smiled too. Everyone at the Institute anthropomorphized corn; Willow used to find it ridiculous when she first started here, but now it seemed natural. And this corn *was* cute—tiny plants, no taller than wheat, with a spray of succulent leaves and thick robust stems, burdened by ears bigger than the rest of the plant.

"Anyway," Andre continued. "They're

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not stable yet, so shit like this is to be expected. Did you find this mutation in the library?"

"Uh huh, only it's not from corn. It's a cauliflower gene."

"You're shitting me."

"See for yourself." Willow moved the sheaf of papers toward Andre. "See? This is all corn, but this little bugger is cauliflower. Except for this G and that A."

Andre nodded. "Don't tell me. We used the cauliflower mosaic virus as a vector for this one."

Willow did not comment on stating the obvious. Instead, she thought of the viruses—always multiplying, always mutating—especially in Alaska, so close to the polar ozone hole. The rest of the country was even worse off, with its scorched land and tepid oceans, with its heat and dust storms, but here . . . Willow shook her head. Not even glass and cement of the Institute could keep them contained.

"What?" Andre said.

"Do you ever think that viruses made us bring them here?"

He stared at her, unsure whether she was joking. "Made us bring them here how?"

"By making us smart. Too smart for our own good, so we messed up everything, and the viruses are our only hope, and we put them into every living thing, we give them new genes to carry around from organism to organism, we make UV radiation so high that they mutate like there's no tomorrow." She bit her tongue.

"Viruses made us smart?"

"Why not? We use them to make things better, to shuffle genes about. They could've done it on their own. The unseen force of evolution."

He sat down, rubbing the bridge of his nose with two fingers. "It's possible, I guess. But what do we do with the dwarf?"

"Start over."

Andre made a face. "You sure we can't fix this one?"

Fix virus with virus, Willow thought. And why wouldn't they? She was doing the same thing—she introduced a virus into her body to counteract the effects of the one her parents put in her. She imagined that virus when she was a kid. In her mind, she pictured it taking her melanin genes and twisting them into little black coils, tight like braids of her old neighborhood friends, so they would lie dormant and not betray her blackness to the world. Now, quite grown up, she imagined the virus untwisting them, she imagined the pigment seeping through her cells, reaching the surface of her skin, coloring her—like a letter written in milk, she was just waiting for the right stimulus to reveal her hidden meaning. She was white paper, and the black viral letters would soon become bright enough to read.

"Willow?"

"I suppose," she said. "Maybe. 'Fire with fire' is our motto, right?"

Andre looked puzzled. "I don't think you're having a good day."

"I'm having a great day," Willow said, and stood. "I'm going to the greenhouse."

"Grab me a tray of EB-A seedlings, will you?" It was Andre's pet strain; he called the seedlings 'babies.'

"Sure thing. How're your babies doing, by the way?"

Andre sighed. "Tumorously. If that's a word."

"It should be."

In the greenhouse Willow walked along the aluminum benches with rows of trays housing green sprouts. Each tray bore a label indicating its strain and growing conditions—with traditional agricultural soils gone to dust or underwater, everyone at the institute worked hard to create corn that would grow in the peat and sand of Alaska.

Willow sighed as she ran her fingers along the tender stems. Poor plants, she thought, they don't know what they are and don't remember what they're sup-

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posed to be. The only choice they have is to grow blindly in every direction, whipped by viruses that changed them with their alien will. Tumorously.

Willow caressed the fabric of the caftan, gingerly tracing the pattern of blue and orange stripes. It seemed too loud, too boisterous. Expensive, too, ever since all cotton had to be imported from Canada. Nonetheless, she put it on.

"It looks good," said the store clerk the moment Willow stepped from behind the curtain of the dressing room.

The woman in the mirror seemed as foreign as the caftan that slithered along her body, shifting and shimmering with every breath. The woman with dark glossy skin. Willow did not belong inside either of them; she could not take off her skin, and so it was the dress that had to go.

"Didn't like it?" said the store clerk when Willow, back in her white blouse and blue slacks, handed her the caftan. "Too bad; it looked really good on you." She smiled wistfully, a pale freckled girl. "I wish I could pull off wearing something like that." She clamped her hand over the startled 'o' of her mouth. "I didn't mean it in a bad way."

"I know," Willow said, smoothing her short hair. "Don't apologize. And it's a nice dress, but I couldn't wear it for work. And I don't go anywhere else."

The store clerk nodded. "I understand. And I'm sorry."

Willow bought a white blouse and a pair of long, jangly earrings to combat her guilt. She felt fake, undeserving.

She walked home. In these high latitudes, darkness all but disappeared in the summer. Nine P.M., and the sun still shone through the thick haze surrounding it. Even at night there was no respite from the radiation.

Willow hated to imagine what happened to the rest of the country. With Florida submerged and Pennsylvania a thirsty, cracked desert, with dustbowls and tornadoes, they were lucky to have a place to go. After Alaska, there would be nothing left. They had to make do.

Science can fix everything; didn't they promise her that? Didn't she become a scientist because she believed that scientists solved problems? Survival, she reminded herself. They had to feed what was left of the population—twenty million? Ten? The government didn't publish the latest census data. They had trouble enough keeping the trains running between Alaska and Canada, and trading what remained of the oil in the former ANWR for goods and research funding. Suddenly, science wasn't a search for truth; it became a search for food and for continuing life. What could be more important than that?

When she got home, she tried her new earrings on and cried. Her tearstained eyes glanced at her hand, and she contemplated it a while—deeper dark around the fingernails and in the creases of the joints, lightening at the phalanxes, and pink at the palm. Tiny moons of her fingernails seemed to hover above the darkness of her fingers. She cried for herself and for her poor corn plants, which she could not make better. The plants whose soul was eaten away by the viruses, and nothing could restore it to them, not even viruses themselves. They died because there was nothing for them to be; she feared to continue this thought and played with her earrings instead.

The next day she came to work early and ran the labyrinth of glass corridors and elevators to the safety of her lab like a gauntlet. She wanted to be in the comfort of her equipment, in the shared misery of her plants. Before she could turn the thermocycler on, someone knocked at the door.

Willow jolted upright and fought a sudden urge to cover her face with her hands. Through the glass door, she saw the smiling face of Emari from the transposon lab down the hall.

"Come in," Willow said.

Emari grinned and entered. "Going to

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the conference in Anchorage next week?"

Willow shook her head. "I have nothing to present. The dwarves wouldn't stabilize. What about you?"

"I'm going," Emari said. "We found some freaky stuff with Mu21. It just loves that UV light. Loves it. And I think if we move to transposable mutagenesis, we might be able to dispense with viral vectors altogether."

"Trying to put me out of work?"

Emari laughed. "Of course not; we'd never lose such a good gene jockey as you. What do you care about the vector? Just make us new mutations, and our little Mu will take care of them." She grew serious. "Besides, Andre tells me that you've had some thoughts about viruses that were . . . let's say, not very flattering."

"Uh huh."

"Want to get some tea?"

"Okay. But let's go outside."

Emari glanced at the window. Heavy clouds rendered the world grey—low enough UV to venture outside for a few minutes. "Sure."

The two women strolled along one of the paths that transected the institute's garden. Initially, it was meant as an enticement for the visitors and the advertisement for the donors, showcasing all of the Institute's achievements; now, Willow and Emari exchanged a sad smile at the sight of these monstrous plants, violet and bronze, their leaves leathery, their stems bulbous, ill. There was no funding to maintain the garden, and only the ugliest and the most resilient plants persisted, UV light be damned.

The women sipped their tea tasting of grass—the best they grew in Alaska.

"Look at those colors." Willow pointed out an especially brilliant plant, streaked in florid bronze and dark purple.

"Yeah," Emari said. "Wild transposons are turning on. I wonder if they would do a better job than us." She drained her cup and turned to Willow. "So what's with you and viruses?"

Willow wasn't sure if she was asking about her skin and shrugged. "Well. Human history was run by viruses. We wouldn't even be in the Americas if the Spaniards' viruses didn't kill off the locals. They wouldn't need so many slaves, too, so there would be no African Diaspora. The influenza epidemics helped the Allies to defeat Germany in the WWI, so without it . . . who knows? And if it wasn't for AIDS and Ebola, we wouldn't all fit in Alaska."

"And?"

"And it's the same with evolution, I think. How many genes were translocated by viruses? Even your transposons are just viruses without anything but the DNA."

"That's why I love them," Emari said. "Transposon is a perfectly abstract parasite."

"Well. They are good at it, you know? I can't help but think that we're just their tools, letting them do what they do best. Bringing them wherever they want to go."

"So evolution and human history are just a massive viral conspiracy." Emari was not laughing anymore and looked at Willow with worry in her green eyes.

Willow shrugged. "Do you really feel that in your relationship with transposons you're the one in control?"

Emari shook her head. "It's a battle, no doubt. But may I ask why you're helping them?"

"This?" Willow raised her hand. "I'm just reversing the treatment I had after I was born."

"Oh. It is quite smart, actually; I hear that melanin offers some protection against UV. Soon, everyone will be doing it."

Willow cringed. If Emari was right, soon everyone would be like Willow, the color of their skin divorced from meaning or history. It would be just an adaptive trait. Like the violet streaks on the corn.

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Willow woke up in the middle of the night, her hair damp with sweat, her thoughts more lucid than ever, the skin on her hands and feet burning. She sat up and stared at the billowing of the white curtains on the windows. The answer came to her in her fevered sleep, and for a while she wasn't able to accept it.

The cancer, the dying corn, her own misery; it all happened because they had forgotten who was the master in this relationship and who was the servant. Things went bad because people decided to manipulate the viruses without understanding them. From the very first pox-infected blanket, things went wrong. Viruses did not take kindly to their rightful place being usurped.

Her legs wobbled under her as she stood and threw on some clothes. She was going to set things right, to let the viruses roam free like they were meant to, to paint their unfathomable designs in skin and leaves, without interference from human meddlers.

The Institute was empty, except for a security guard who gave her an indifferent look. No doubt, he was used to wild-haired scientists experiencing breakthroughs and running for their sequencers at any hour of the night. Willow waved at him and stumbled for the elevator.

She stopped by the lab to load up a cart with cell cultures that harbored viruses of every stripe with every imaginable corn gene inserted into them, and pushed it to the greenhouse, often stopping to wipe the sweat that ran down her face. She tried not to think about whether it was the virus inside of her that pushed her on, getting giddy at the impending freedom of its brethren . . . she chased such thoughts away.

In the greenhouse, she flicked on the daylights, illuminating the experimental plants in all their sickly, tumorous nudity. If she didn't do something, they would never get it right. People would starve. People would burn to the crisp and die. They would poison what remained of the air and the water. It wasn't their fault; they were just not equipped to do the viruses' job. She had to trust the viruses to make it better.

Willow emptied the dishes over the plants, smearing thick translucent cellular jelly over leaves and stems. She pushed apart the heavy glass panels that protected the plants from the ravages of the outside air and gulped the night and the coolness with wide-open mouth. She poured the leftover viral cultures over the plants in the garden below and threw the empty Petri dishes after them.

She waited for the sound of shattering glass, gripping the windowsill. The creases on the joints of her fingers looked pitch black and she could feel the restless shimmying and shifting of the virus in her blood. It made her hair sing like taut violin strings, it made her skin burn.

Willow had to lean against the wall as her legs grew weak. She felt no fear, only the calm assurance that the plants would flourish. And after that, she would find a way to liberate the human viruses, to let them shape the humans as they had been doing for thousands of years.

She stroked her skin, burning, hot to the touch, almost smoldering under the viral assault. "Be still," she whispered. "I will take good care of you." ■

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REAL NUCLEAR FUSION ON A TABLETOP

In the December 1989 issue of *Analog*, I wrote an AV column entitled "Cold Fusion, Pro-fusion, and Con-fusion" that described and gave my opinions about the recently announced "discovery of cold fusion" by Stanley Pons and Martin Fleischmann. These University of Utah electrochemists claimed that by electrolyzing D_2O (heavy water) on a tabletop, they had produced the nuclear fusion of deuterium (mass-2 hydrogen) nuclei inside a palladium electrode, generating lots of extra heat but no significant radiation. My column was written very early in that controversy and the dust had not completely settled, but it was clear to me at the time (and is still clear) that the reported results were an example of bad science and overblown claims.

By contrast, in this column I want to report on a well-executed experiment performed by B. Naranjo, J. K. Gimzewski, and S. Putterman (NGP) of UCLA that demonstrates the *successful* production of the nuclear fusion of deuterium with a relatively simple tabletop experiment. It was reported in the April 28, 2005 issue of the science journal *Nature*. The announcement of this breakthrough produced hardly a blip in science-based news reports, perhaps because many science reporters had previously been burned by the overblown Pons and Fleischmann affair.

So what is d+d nuclear fusion? Let's review the process. Nuclear fusion is the primary energy source of the Sun. High temperatures and pressures near the Sun's center drive the fusion of hydrogen into helium, releasing lots of energy. Here on Earth, we would also like to use fusion as our primary energy source, but, with the exception of thermonuclear bomb explosions, we have yet to master the trick very well. One must bring two deuterium nuclei (mass-2 hydrogen containing a proton and a neutron) close enough together that they can fuse. This fusion could, in principle, form a single helium nucleus (2 protons + 2 neutrons), and a gamma ray, liberating about five million times more energy than could be obtained from any chemical reaction between two atoms.

However, there are several problems with achieving this. First, both deuteron nuclei have a positive electrical charge. When they get close, these charges repel, producing a large electrical force that pushes the nuclei apart. One must overcome this force with either high temperatures or acceleration to bring the deuterons close enough to fuse.

The second problem is that a fusion process must simultaneously obey the law of energy conservation and of momentum conservation. Because of this dual requirement, the d + d fusion reaction makes helium-3 plus a neutron or hydrogen-3 plus a proton with much higher probabilities than it makes helium-4 plus a gamma ray. Therefore, any d + d fusion reaction should be a prodigious source of fast neutrons, i.e., neutron radiation. As someone said in 1989, Stanley Pons' own announcement refut-

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ed his claims, because if his experiment had actually worked, he would have died of neutron exposure before reaching the microphone.

On the other hand, the NGP experiment *does* proceed by the d+d→ ^{3}He+n reaction and *does* make lots of neutrons. It gets the deuterons close enough to fuse by accelerating one deuteron to a kinetic energy of about 115,000 electron-volts and slamming it into another at-rest deuterium atom by using a heated 1-cm-thick ferroelectric crystal of $LiTaO_3$ (lithium tantalate) to produce a very large electric potential (~115,000 volts).

What? A 1-cm-thick crystal producing a 115 kilovolt electric potential? That sounds like magic! Yes, I suppose it is magic in a way, the kind of quantum magic that occurs in some crystals called the ferroelectric process.

To understand it, let's first consider ferromagnetism. The atoms of the metals iron, cobalt, and nickel contain little built-in magnetic compasses, each with its own little needle with a north and a south pole, called its magnetic dipole moment. Many materials have such magnetic moments, but in the ferromagnetic materials they like to line up to form a permanent magnet, with most of the atoms pointing their little compass needles in the same direction, so that a bar of the material has a definite north magnetic pole at one end, a south magnetic pole at the other end, and a fairly strong magnetic field around the bar. This occurs because, for subtle reasons involving quantum mechanics, a ferromagnetic system with the magnetic moments of its atoms lined up has a lower net energy than does one with the magnetic moments pointing in random directions. We have now seen this quantum magic in magnets so frequently that we take it for granted and use it to stick notes and pictures to our refrigerator doors without thinking about it.

A ferroelectric crystal works the much same way. Individual molecules of the crystal have an electric dipole moment, with a net positive electric charge on one end of the molecule and a negative charge on the other end. Again, for subtle reasons involving quantum mechanics, a ferroelectric crystal with its electric moments lined up has a lower energy than one with the electric moments pointing in random directions, creating a sheet of positive charge on one end of the crystal and a sheet of negative charge on the other. This is not a new discovery. It was first described by the Greek natural philosopher Theophrastus in 314 BC, it has been studied for many years by condensed-matter physicists and chemists, and it is the basis for a commercial device that produces low-intensity X-rays.

In analogy with the poles of a permanent magnet, the ferroelectric crystal has a definite positive-charge end and negative-charge end. Under the right circumstances, particularly when it is heated (pyroelectricity), it develops a sizable electric potential between them. However, in air the electric field of a ferroelectric material is not so easy to observe because it is rapidly dissipated by polar molecules (e.g., water vapor) attracted to the surface and neutralizing the net charge. In a vacuum, however, this does not happen, and significant electric fields can be produced by the pyroelectric process as the crystal is heated.

The UCLA group placed a cylindrical 3-cm-diameter by 1-cm-thick ferroelectric lithium tantalate crystal in a vacuum vessel to which deuterium gas at a pressure of 0.7 Pa (0.0001 psi) had been admitted. The crystal was mounted with its negative end attached to a temperature-variable copper block and its positive end supporting a copper disc with a sharp tungsten spike at its center. The spike was 0.080 mm in diameter, 2.3 mm long, and had a tip radius of 100 nanometers. When the positive end of the crystal reached its maximum electric potential, the electric field near the

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tip of the tungsten spike was very large (greater than 25 volts per nanometer), strong enough to pull loose the electron from a deuterium atom and send the positively charged nucleus in the other direction. Thus, a beam of ionized deuterium nuclei was given an energy of up to 115,000 electron-volts and directed against a grounded target plate placed opposite the crystal. The target plate supported a sheet of deuterated polyethylene, providing deuterium atoms with which the beam of deuteron ions could collide.

The crystal was temperature-cycled, first dropping its temperature to 240 K (-33 C) using liquid nitrogen and then progressively raising the temperature with electrical heating while observing the results with neutron and X-ray counters. After 100 seconds of heating, X-rays were observed from free electrons in the gas hitting the positive copper disc and crystal. After 160 seconds the neutron signal rose above background and increased rapidly until 220 seconds, when the heater was shut off. Neutron emission then began to drop as the deuteron beam bled off charge faster than the pyroelectric current could replace it, but strong neutron emission continued until 393 seconds when a spark discharged the system.

The reported measurements show clear evidence that the nuclear reaction $d+d \rightarrow {}^{3}He+n$ had been produced, that the system had produced a deuteron beam ion current of 5 4.2 nA and had produced about 900 neutrons per second. Subsequent measurements at Rensselear Polytechnic Institute have confirmed the UCLA measurements. Therefore, a tabletop experiment has successfully produced controlled d+d fusion. This was accomplished using well-established physical phenomena and has required no "visits from the Tooth Fairy" to make the process work.

There are some obvious improvements that could be made to the fusion demonstration configuration used by the UCLA group. First, there is no reason to attach only one sharp spike to the copper disc. As long as spikes on the disc are separated by distances greater than their length, they can operate as independent sources of deuterium ionization. Thus, one can imagine a "bed of nails" configuration using a copper disk equipped with perhaps 100 such tungsten spikes. This would in principle increase the fusion reaction rate and neutron yield by two orders of magnitude. Second, the Rensselear group has demonstrated that by using *two* pyroelectric crystals mounted in opposing positions with oppositely charging faces, the electric field can be doubled. For example, in the NGP configuration the deuterated target could be located on the negative face of a second pyroelectric crystal, with both crystals cooled and heated together, to produce a deuteron beam with a kinetic energy of 230 keV for the reactions, allowing the deuterons to travel further into the target and make more fusion reactions before losing too much energy to react. One could even think of stacking many crystals to achieve significantly larger potential differences. Third, if the target was made of a material loaded with tritium (mass-3 hydrogen) instead of deuterium (mass-2 hydrogen), the fusion reaction rate and neutron production rate would be about 100 times larger, and would produce neutrons that are six times more energetic (about 15 MeV instead of 2.5 MeV). We also note that by replacing the low-pressure deuterium in the vacuum vessel with low-pressure helium-3, one could produce "radiation-free" energy with the $d+{}^{3}He \rightarrow {}^{4}He+p$ fusion reaction, which produces no neutrons and would be very easy to shield in a power-production context.

Thus, tabletop controlled fusion is now a reality! What does that mean? Are we on the brink of the new controlled fusion age of pollution-less and virtually free energy? Should we hold off buying

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new car until the fusion-powered models become available? Sorry, it's not that easy.

The NGP demonstration experiment, even with the improvements suggested above, is far from the "break-even" point of reliably producing more energy than it consumes. Further, the amount of energy it does produce is very small, and the system reliability for long-duration operation, depending as it does on the robustness of lithium tantalate crystals against radiation damage, is not at all clear. Like any new technology, it needs to be explored further and is likely to encounter unforeseen problems and produce unforeseen applications.

But in any case, it represents a small, inexpensive, and convenient method of producing a beam of neutrons. This has applications for material studies and for medical cancer treatment and imaging. In the latter context, the NGP group has already demonstrated that it is possible to "tag" the direction of an emerging neutron by measuring the direction of the recoiling ^{3}He nucleus that was produced in the same reaction, since the two particles are emitted back-to-back in the system center of mass frame. Thus, if a neutron was scattered by or produced a nuclear reaction in some material, one would know the direction the neutron was traveling before the event occurred. This could have important element-analyzing imaging applications, both in medicine and in areas like homeland security and nuclear weapons safeguards. A space-based variant of the deuteron-ionizing setup could also provide the basis for a new type of ion thruster.

Seth Putterman has stated that with this new technology, one could construct a sealed egg-size device, place it in ice water for a while, then hold it in your hand to bring it up to body temperature, and this would cause it to emit enough neutrons to give you a dangerous radiation dose. That does not sound very useful, but it illustrates the power of this new fusion technology. ■

AV Columns Online: Electronic reprints of over 130 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available online at: http://www.npl.washington.edu/av.

Reference:

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"Observation of nuclear fusion driven by a pyroelectric crystal," B. Naranjo, J. K. Gimzewski, and S. Putterman, *Nature 434*, 1115-1117 (2005).

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On the Quantum Theoretic Implications of Newton's Alchemy

Alex Kasman

We're often warned to be careful what we wish for—and the devil is in the details!

Only the skin around Rick's left eye wrinkled when he gave me the good news. That's a bad sign. Normally, the crow's feet around both eyes become more pronounced when he smiles. They don't make him look old, just extremely happy. But occasionally the wrinkles are only visible on one eye or the other.

I must have witnessed this event twenty times during the four years that Rick served as my thesis advisor. I also remember a few examples of these one-sided smiles during the previous year, when he taught the *Topics in Modern Analysis* class I took and was also the professor for the statistics class that I TA'd. Based on this empirical evidence, I developed a theory to explain this "broken symmetry": Rick's non-symmetric, smile-induced wrinkles always indicate that he is lying.

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It gets even more specific than that. I vas relatively certain that right side vrinkles suggest that Rick has some-hing extremely positive to say, but feels hat he has to restrain himself. For in-tance, if one of the two really bright tudents in his statistics class made a par-icularly insightful remark during class, I hink Rick would have liked to have aid, "That's fantastic! You're a talented 'oung mathematician. Have you consid-:red majoring in math?" But, worried hat saying this would bloat their egos or)ffend the rest of the students, he would nstead just say, "Yes, that's correct." This sort of remark was generally ac-:ompanied by wrinkles around his right :ye, and so I was proud to have earned i few right-sided wrinkles during his dis-:ussion of my progress on my thesis.

On the other hand, sometimes he had :o smile when he really didn't feel like it. Comments like, "The department has voted to let me serve as chair again start-ng next semester," or, "Despite your ow grades so far, if you study really hard)efore the final, you can still earn a good grade in this course," are the sorts of :hings he is likely to be saying while smiling with wrinkles around his left eye)nly.

So I was a bit concerned when he :old me of the job offer from Dr. Stein. On the surface, it really seemed to be good news. Despite the difficult job mar-ket, especially for people in my field of non-standard analysis, I had at least one firm job offer.

But only the skin around Rick's left eye wrinkled when he gave me the good news.

"What do you think?" he asked me as we walked through the flurry of cherry blossom petals on the central quad. "Does that fit in with your plans?"

As if I *had* plans! My plan was to get my degree and get a job. If this was a job, then it fit with my plans. As it was, I received no other job offers, and so had no choices to consider. Not only that, but it was a research post-doc at a math-ematics institute! And, from what I've heard, Ann Arbor isn't such a bad place to be either.

As I said, it seemed to be good news, but the wrinkles got me worrying.

It *was* a little bit strange that the job offer came without my even having to send an application. And, I have to admit, I'd never even *heard* of the "Institute for Mathematical Analysis and Quantum Chemistry," a research center that seems to have absolutely no web presence at all.

Perhaps they do government work that is so secret, security precautions prevent them from having a webpage.

Perhaps the one-sided smile just meant that he was saddened by the thought that I would be leaving soon.

Perhaps my theory about the symmetry breaking was just plain wrong.

Or perhaps things were about to take a turn for the worse.

These were the possibilities I was considering as the train pulled into Ann Arbor. I got out of my seat and started pulling my old green duffel from the rack before we had come to a complete stop. So, when the train finally did stop, the cumbersome bag made me lose my balance and fall on a woman talking on her cell phone. Her eyes narrowed, as if I'd just tried to steal her purse, but her phone conversation continued as if nothing had happened.

I was still apologizing to her as we entered the terminal building, but I was pulled away by a small man who tugged on my shirtsleeve and meekly asked, "Are you Igor, then?" Raising my hand one more time to try get the attention of the woman who headed for the bathroom, still chatting away on her phone, I recognized the futility of my desire to be forgiven and turned toward the man. My duffel slipped off of my shoulder and fell to the ground, making a sound that would make one think the bag contained a dead body rather than the cheap clothes and toiletries it actually held.

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"Yes," I said holding out my free hand, "and you are?"

"I'm Doctor Stein, from the institute."

Well, I was impressed. The director himself had come to the station to pick me up. That seemed promising. And my first impression of the man was a good one as well. His brown plaid shirt may have clashed a bit with the blue slacks he wore, but he looked friendly. Moreover, although I am not sure exactly what it is about him that gave me the immediate sense that the man was a genius, I was already convinced that Stein was brilliant.

"But you can call me Frank," he continued, shaking my hand. "Can I help you with the bag?"

I suspect that the bag weighed twice as much as Frank, so I just carried it to his gleaming 1972 Ford Country Squire station wagon myself, and we were off.

At first, we just gossiped about Rick. The two of them had apparently met in grad school and only barely stayed in touch since then. For instance, he didn't know that Rick had married the well known number theorist Lisa Rojahn, or that he had been in a water skiing accident and was confined to a wheel chair for almost a year.

We also talked about my name, Igor Stravinsky. Everyone asks about it eventually. I began the usual spiel about the famous composer being a distant relative of mine and how my parents, being very fond of music, thought it would be a good idea to name me in his honor.

But then I noticed a sign indicating that we had entered the city of Ypsilanti, Michigan and I began to ask more pertinent questions about my situation.

"So, are you taking me to my apartment first? Will I be living in Ypsilanti and commuting to. . . ?"

"No, no," he said cheerfully. "You'll be living at the institute with me, and it's *in* Ypsi." Then, seeing that I seemed concerned about this bit of geography, he added: "Don't let that worry you, my boy. Did you know that MSRI isn't in Berkeley, but in Oakland?"

Somewhat comforted by this, pressed on with my questions. "I did try to read some quantum chemistry papers, you know. There was this cool one where they were trying to predict the color of gold just from the mathematics of it. The funny thing was that because the nucleus is so heavy, they got it all wrong unless they included some relativity in there. Well, I understood that much. But really, the details lost me. I don't get Schrödinger equations and all that stuff about particles. How much of that are you expecting me to learn?"

"Particles? Don't worry, you won't be needing that. I can do all of the chemistry. You will just be my 'hired gun,' handling the Riemann-Hilbert problems that pop up."

"I didn't see any Riemann-Hilbert problems in what I read. It's too bad, too, because then maybe I would have understood it. So, could you explain to me how . . ."

"As I said, Igor, don't worry about it!"

Finally, I asked a question that I thought would have a simple answer. "Do all of the institute's employees live there, or just me and you?"

"Yes," he said, and crow's feet appeared by his right eye. There may also have been some by his left eye, but I couldn't see them from my point of view.

"I'm sorry, I guess you didn't hear me. I asked whether you and I alone will live at the institute or whether all . . ."

"I heard you. I heard you. Now, show me you're as smart as Rick says and tell me why I said simply 'yes.'"

It didn't take me long to figure it out, but shock kept me quiet for a bit too long and Frank began to hum the annoying music from the final round of Jeopardy. He really seemed to be enjoying himself.

"Okay," I said with a bit too much anger. "I get it! It's not much of an *institute* is it, if we're the only two people there."

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"It's quite a bit better than it was last week. One hundred percent increase in personnel! Not bad, not bad. And getting better all of the time. Ah ha! And here we are."

I had not been paying close attention to where we were going during the last bit of conversation, and so I was surprised now to see that we were in a residential neighborhood that had clearly seen better days. The houses were relatively large, with fancy woodwork and reasonably good wooden siding. But they were all in serious need of paint, and grass growing in the many cracks made the sidewalk running in front of them almost invisible.

The house we had stopped in front of was one of the better looking ones, the weeds having been trimmed back enough that you could see the steps. It had probably been painted some time in the last ten years. Near the porch steps was a little sign that read "Mathematical Analysis/Quantum Chemistry" in gold letters on a black background.

That pretty much confirmed my theory about Rick's smiles.

My area of mathematical expertise is solving Riemann-Hilbert problems. I like to think of myself as a wild animal trainer, but rather than making lions jump through hoops, it is complex-valued functions on a Riemann sphere that are doing the jumps for me. Calculus students are used to seeing well-behaved functions: continuous and differentiable everywhere. But in many applications, you not only need functions that have discontinuities, but you need them to jump in rather specific ways at prescribed locations.

The thing is, it can be pretty difficult to make the functions dance the way you want them to, especially when the moves get fancy. Using the stuff that most mathematicians know, it can appear like a nearly impossible task, giving these sorts of problems a reputation for being onerous. But, I'm lucky that Rick knows the latest mathematical gimmick, a toolbox called "non-standard analysis," that gives me numbers infinitely smaller and infinitely larger than the usual ones. As it turns out, we can use these as treats to coax the functions to do just what we want. It's still a lot of work, but it is straightforward enough, and not nearly as dangerous as lion taming!

My job at the institute pretty much consists of using these techniques to solve the Riemann-Hilbert problems that Stein tosses at me. He'll have to carefully describe the jump he wants, where he wants it, and the boundary conditions that cage up the wild function away from the jump so that it is always under control.

After I had been doing this for just a few days, Rick actually called me to see how I was doing.

"This job isn't so bad after all," I told him. "The problem I worked on yesterday was really cool. You should have seen the monodromy that I ended up with! At first I couldn't think of what I could do until I used a Möbius transformation and it all fell into place. You know?"

"Yes, I know." Rick sighed and paused. "Has he talked to you about, uh, chemistry?"

"No. He told me not to worry about that side of it."

"Okay. Well, keep in touch."

As I hung up the phone, I had to remind myself of where I was in my latest computation. It was essentially done. So, I finished up what I was doing by writing a brief note to Stein:

Remember, in the last formula you've got to think of the jump matrix as being an operator on the nonstandard *Hilbert space* H. *Then, using your curve C we can get the answer by using*

$$\chi(\lambda)=I-\int_C F(\lambda)\,G(\mu)/(\lambda-\mu)\,d\mu$$

I'm not sure why Rick seemed so worried about me. I was really beginning to have a great time. Living with Dr. Stein

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in the old house may have been a little bit unusual, but since he didn't care what I did with my time off, it wasn't like living at home with mom and dad, as I had originally feared.

In any case, he seemed mostly to approve of what I chose to do with my spare time, which was to hang out on the University of Michigan campus with the math grad students. I attended their colloquia and seminars. I joined them in the U. Club for beers. And I enjoyed a picnic lunch on the Diag with one student in particular, with high hopes of seeing quite a bit more of her.

Dr. Stein, whom I still cannot quite bring myself to call "Frank," approved of this because he wanted me to stay connected to the mathematical community. He also seemed to want me to report back to him anything that anyone should say about him. And I did. I told him that his early work in mathematical physics on anti-deSitter spaces (whatever those may be) is apparently still respected, but that he is now considered quite the crackpot. I told him that the department was trying to figure out how to fire him despite his tenure. And I told him that people are very curious to know what we were doing at the institute.

Since he had not sworn me to secrecy or anything, I was comfortable passing information back the other way as well. I told my friends in Ann Arbor that Dr. Stein was definitely not the craziest person I'd ever met. As far as work goes, I told them that he would frequently give me rather specific Riemann-Hilbert problems, which needed to be solved, and that he was always very grateful and positive when I was able to find solutions relatively quickly. I had no idea what he was doing with my solutions or what it had to do with chemistry.

On our first official date, Becka and I caught a showing of "How to Steal a Million" with Audrey Hepburn at the Michigan Theater. We had seats right up front by the pipe organ, and somewhere in the middle of the movie her knee rubbed gently against mine and it stayed there.

Everything was going great. But later, over coffee, she started asking me about my job again. She asked the same questions she had asked at our picnic lunch last month, and I gave her the same answers. I thought I was being romantic when I asked why I should care about Franklin Stein and his micro-institute when all I could think about was her. She didn't agree.

The next time that Dr. Stein looked over my latest solution, inquiring about the details as usual, I interrupted him with a question of my own.

"It looks nice," he was saying. "Yes, very nice. I think we're getting quite close to our goal now, boy. It won't be long now until they see that I'm not such a 'crackpot' after all! Just one question: Are the branch cuts double ramified along the . . ."

I was barely listening to him. Instead, I was looking over his shoulder at the paper he had been working on. Below some complex analysis that I recognized, large and bold, I saw the expression:

$$\sharp\sharp\odot+O(\sigma)\rightsquigarrow\natural+O(\varphi)$$

I was thinking, "What is this, *astrology*?"

"What *is* our goal, Frank?" I found myself shouting. I had never taken him up on his offer to call him by his first name before, and so he knew right away that I was annoyed.

"I will tell you, son." He spoke calmly, a significant contrast to my agitated state. "You seem pretty bright and may be able to understand the importance of this work more than most of them. But first, are you sure you want to know?"

Ignoring his polite response, I continued yelling out things I hadn't realized I had been thinking. "You know, I took classes in quantum physics and chem-

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istry in college. I read a few papers on quantum chemistry before coming here. And I never saw *any* Riemann-Hilbert problems in them. Are you even doing anything with the answers I'm giving you, or do you just go off and come up with another problem for me to work on? Is that what all of this is about, just wasting my time?"

"We are not wasting anyone's time. We are doing extremely important work here, Igor. The course of history will change." His voice became deeper and very nearly boomed as he said, "After these many hundreds of years, Isaac Newton's dream will become a reality. By piecing together a bit of this field with a smidgen of that theory, we are resurrecting the greatest scientific achievement of all time, which died a slow and painful death from neglect and misunderstanding."

I think he would have gone on with this declamation if I hadn't butted in sarcastically with, "What? Did Isaac Newton do *quantum chemistry?*"

"In fact, he did. Yes, Isaac Newton invented quantum chemistry as far as I'm concerned. Of course, he would not have called it that."

I waited for him to continue, but apparently it was my turn to say something. So, after a reasonable silence, I went ahead and set him up as he wanted. With obvious skepticism, I asked, "All right, you win: What would Newton have called it?"

"Alchemy!"

It was quite rude of me to just walk out on Dr. Stein without saying a word, but I needed some time to think about this.

Alchemy, huh? That's what we're doing at the institute: turning lead into gold! I would have been seriously embarrassed to tell my friends at the University about that, and I suspected that it would not look good on a CV. Could I get hired, I wondered, at a real math department after spending a year doing witchcraft with a loon?

Consequently, I was mad and worried, and I just turned around and walked out of there. But I guess I had grown to trust Stein at least a little bit, and to like him as well. So I wanted to at least consider the possibility that he knew what he was doing.

That's why I didn't just get back on a train home, but instead went to the grad library and did some reading about alchemy.

There were some things I learned that I had not known. For instance, Isaac Newton really *did* work on alchemy! (One point for Stein.) I had too much respect for Newton's mathematical discoveries to discount him as another complete wacko. On the other hand, everything else I read just reinforced my impression of alchemy as an early pseudo-science based more on wishful thinking than scientific rigor. The experts agree that people who believed in alchemy back in the seventeenth century were basically crackpots, and anyone who still believes it today is just plain nuts. (By my reckoning that made it two to one against poor Dr. Stein.)

I should definitely have gone back to the institute at this point, packed my bags, and headed for home. That was certainly my plan, but I saw the light on in Dr. Stein's room and knocked lightly on the door.

He seemed to know that I was planning to leave, and I was starting to feel guilty.

"Don't go now, Igor. I'm . . . *we're* so close!" he pleaded.

"You can do it without me, Dr. Stein. You wouldn't want me around anyway if I don't believe, would you?" I thought that perhaps, like psychic powers and homeopathy, alchemy could be something that never seems to work when a skeptic is around.

"I can do almost all of it without you, and have been for years. But I never could understand that non-standard analysis that you do."

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People are always saying that to me, and I don't understand why. "It's easy," I assured him. "Just pretend that there are real numbers that are infinitely big or infinitely small and do what you always do in a calculation."

"It is easy for you, and that is a gift. I would be ever so grateful if you would share that gift with me just *one* more time. I really think I've got it now. Solve this problem for me and tomorrow I can show you that I really do know what I'm doing."

Pity is not one of my favorite emotions, and I resented him for playing on it. But his ploy worked. I stayed awake that night deriving complex functions with prescribed jumps for my boss one last time.

I probably was not looking my best when I wandered into the kitchen at 6:30 in the morning, where I found Stein waiting for me with a fresh pot of coffee. As I struggled to stay awake and dunked my donut, he tried to explain the whole idea to me.

"What did Newton do, before he turned to alchemy?" he asked rhetorically. "He wrote down formulas for matter moving under gravity, *and* he came to understand the wave nature of light. Then, he took a leap that was too big for any of his contemporaries to follow: he put them together."

"So, you're saying he discovered a theory of quantum gravity," I said between sips, "just like all of the physicists are trying to do today."

"Yes, but he had quite an advantage because he didn't spend hundreds of years believing in nonsense first."

"What nonsense would that be?" I inquired, thinking that for the first time, Dr. Stein was beginning to look as unhinged as all of my friends said he was.

"Particles, my boy! The idea that matter is made up of particles is a terrible mistake our physicists made early on and we've been paying a price for it ever since."

"Of course matter is made of particles," I said patronizingly, though I was well aware that my limited background in college physics was nothing compared to his years of experience at the forefront of mathematical physics. "I think we're pretty sure of that. Molecules, atoms, electrons, and protons. I learned all about that in school and I've heard friends talking about things like quarks and moo-ons. Particles are an established fact, not nonsense."

"You mean *muons*. Yes, of course. I learned about all that, too. I learned the standard model. I even proved a theorem about super-symmetry that particle physicists are always making use of, but that doesn't mean it is an accurate description of the real world. I also learned that Columbus discovered America, but by the time you went to school, they knew that it was not quite true. Here, let's try this. You say you took a course in quantum mechanics, right? What did they tell you about the speed and position of a particle?"

"That you can't measure them both at the same time."

"Yes, but there is more to it than that. Even physicists will tell you it is not only that the particle has a speed and a position that you do not know, the particle does not even *have* a position or a speed until you measure it."

"Yeah, I suppose I've heard that," I said, beginning to wonder whether all physicists are nuts. "That never quite made sense to me."

"And I'll tell you a simple way to solve the dilemma: get rid of the particles. There are no particles after all, only waves. The particle is just a figment of our imagination, and that is why it only has the properties we know it to have. *This* is what Isaac Newton realized when he combined his understanding of gravity with his experiments on light: all of this around us is just a big wave, rippling and moving under the force of gravity. The gravitational effect may make it look like there are particles, but looks can be deceiving, no?"

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To demonstrate this last remark, he held the eraser of his pencil loosely between his fingers and shook it up and down quickly. It sure looked like it was flopping around like a rubber tube instead of a wooden pencil, and I just had to laugh.

"But," I said, almost starting to believe him, "if Newton knew all of this, why didn't he tell anyone?"

"He tried! That's what his *fluxions* were, a new mathematical notation for the wave nature of reality itself. If only he'd had your non-standard analysis to make it rigorous, people might have seen what he was getting at. But, as it was, they thought it was just an inferior attempt at defining derivatives and chose to go with Leibniz instead. But he wasn't just talking about functions and calculus; he was talking about the ultimate description of reality. That's what his alchemy was about."

"Okay, so now we get to it! What does it have to do with alchemy?"

"That's what alchemy *is!* Look, today's scientists with their belief in particles wouldn't try to turn lead into gold. How could they? Particles are particles, unchanging by their very nature. But suppose instead that lead and gold are just different ripple patterns in a wave. With the right sort of nudging, you *can* change one into the other. I'm not just talking about a theoretical possibility. I know exactly what I need to do now, and I'm about to do it!"

"You mean you're *really* trying to turn lead into gold? Come on, even if I believed you could do it, isn't there something more useful you could be doing with this new science of yours?"

"Sure, sure. If today's experiment works, I'll move on to something bigger: producing the *philosopher's stone*. The ultimate, universal substance, entirely unknown to modern science, a quantum superposition of the resonance patterns of all of the other elements. Newton proved its existence mathematically, but was never able to work out how to make any. All of the alchemists of his day set creating some as their highest goal. The associated Riemann-Hilbert problem might be so hard that even *you* would have trouble solving it . . . but that's for another day. Today, we need to turn lead into gold because *that* is what it takes to get the attention of the media."

"Well, there I guess I can agree with you, Professor Stein. If today's experiment works and you really turn lead into gold, then you could have a TV news crew here tomorrow and . . ."

"But they are already here! And, today's experiment *will* work. How can you have any doubt? You solved the latest jump problem, no? Well, then we're ready to go!"

It was only then that I noticed how much light was coming from the living room. I had mistakenly believed that it was sunlight, but this time of year it is not so bright so early in the morning. When I followed the professor through the doorway and my eyes became accustomed to the light, I saw that there were several reporters and camera crews set up there. Dr. Stein went over to a computer terminal in the corner and began typing in the results of my night's computations.

A tall man with a huge pile of light brown hair and unbearably white teeth started talking as soon as we entered. "This is Tom Cannon reporting from the home of Dr. Franklin Stein, a U. of M. mathematics professor who is either a genius or a certifiable kook depending on who you want to believe. We are here today because Dr. Stein claims to be able to turn lead into gold using an old science called 'alchemy'. . . ."

Meanwhile, an Asian woman in a short skirt was saying, "The mathematics department has refused to comment, but Peter Watkins, author of last year's best selling *The Alien Abduction Diet Plan,* insists that Stein's approach is well grounded and sure to produce spectacular results. . . ."

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And, most distressingly, the local access channel's young volunteer reporters were doing a terrible job of discussing me and my role in today's spectacular demonstration: "According to Stein, Igor Stravinsky—no relation to the famous violinist—played a key role in his research by solving Rhymon-Dilbert problems, math questions about integrals like those you might have seen in your calculus class. . . ."

While I tried to hide in the corner, all eyes (and cameras) were on Dr. Stein as he began his big show.

"Thank you all for coming here today to witness a tremendous advance in the human understanding of the universe." At this point, he switched on one of those hokey electric spark machines that you see in old horror movies. It was sitting on the coffee table and began buzzing and zapping as the spark climbed higher and higher before returning suddenly to the bottom. "This journey was begun long, long ago. *Al chemie,* like *al gebra,* and even—ironically—*al cohol,* all owe their origins to that period in the history of Arabia when their scientists were at the forefront of discovery. However, they did not know enough about waves to take it through to its conclusion. This, like so many of their great discoveries, was lost to time. Similarly, Isaac Newton, who finally knew enough to put together the main ideas, did not know enough about his own invention, the infinitesimal calculus, to . . ."

"Hey Doc," called out one of the cameramen, demonstrating that despite their mock sincerity, the news crews did not have any respect for Stein as a man of science. "We've only got a little bit of tape left here. Can you get on with it and turn the lead into gold already so we can get out of here?"

A few others snickered, either at the idea that we might actually see lead turned into gold or at the cameraman's rude behavior, but Stein complied politely and dramatically. He picked up a gray, metallic bar from the coffee table and dropped it. It actually shattered the tabletop and fell to the floor with a loud *thunk*. "This is a lead bar," he said matter-of-factly. "This is a generator of vibrations in the electro-magnetic field," he continued, indicating the spark-making thing. "I place the lead bar on this vibrating platform which, like the field generator, is controlled by a digital computer."

"What kind of computer is it, doc?"

"Well, it is a Dell running Linux. But the point is that it vibrates the bar and the electromagnetic field according to the real and imaginary parts of Igor's solution of the Riemann-Hilbert problem respectively so that . . ."

Though I was already in the corner, behind the recliner, I tried even harder to hide at the mention of my name and hoped that Becka was not watching TV this morning. But then, something began to happen. The bar began to shake very quickly, and the pattern of sparks became much more erratic. Then, space itself seemed to bend visibly. This ripple of space began at the bar, but seemed to spread out in all directions, even passing through me—a very strange sensation—before disappearing through the walls.

I was impressed! Dr. Stein really seemed to know what he was doing after all. Or so I thought until I looked at him. He looked quite puzzled and concerned. Soon, however, he looked up again at the camera crews and smiled, proudly displaying a shining gold bar where the dull lead had been previously.

The reporters were temporarily speechless. This was not going to be the humorous "human interest" story they had originally expected it would be. Everyone in the room, even Stein, was only starting to realize the implications of what we had seen. But this sense of triumph did not last long.

Beginning with just a few drops, soon a steady stream of water was dripping down on us from the chandelier. We all looked up at it, still and silent, noticing

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he cracks forming in the ceiling, before aking the necessary action. Everyone an out onto the street as fast as we ould. And we were just in time too, as ve heard the ceiling crash in and saw he living room flooding through the vindows very shortly thereafter.

Up and down the street, every house vas going through the same strange set of circumstances. Wet people running out into the street as their homes and possessions were soaked in a flood of water. (Of course, ours was the only house that had camera crews.)

"I don't understand . . ." Stein whim-pered, not really to me but within earshot. He looked miserable, but I was n a pretty good mood as it looked as if I was actually part of something noteworthy.

"The pipes, Dr. Stein. These old buildings still had lead pipes," I explained. 'You've turned them all to gold, which may earn the homeowners a nice profit n the long run, but for now the problem s that gold is not strong enough to . . ."

"Of course, I know *that!*" he snapped. "But only the bar in our experiment should have been affected. The wave should have dissipated before ever reaching . . . unless . . ."

His expression vacillated between horror and anger as he grabbed me by the shoulders and asked, "The solution, wasn't it compactly supported?"

"Oh, well . . . that didn't seem to be working out nicely," I admitted, "so I used *periodic* boundary conditions this time. Was that, um, bad?"

Behind him I could see an angry mob heading in our direction, accompanied by the local access film crew. So far, they did not seem to be too grateful for our gift of golden plumbing.

"It depends," he asked, with a broad smile but wrinkles appearing only around his left eye. "What do you think the effect will be on the world, on technology, on *the economy* now that every atom of lead on the planet has suddenly become gold?" ■

It's incredible how much intelligence is used in this world to prove nonsense.

—Friedrich Hebbel

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El Dorado

Tom Ligon

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Illustration by Vincent Di Fate

Heroes don't always fit the expected image. . . .

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Victor Gendeg let his eyes adjust as he studied the jumbled ball of dirty ice before him. It was illuminated only by starlight, especially by one bright star about 3.3 light-days away, and his eyes strained to make out any detail. He leaned so close to the window that his breath frosted it. He wiped the white deposit away and held his breath to gaze at it again.

"Computer, voice log on."

"That must be it. Classic exit jumble. Definitely had a collision with a smaller, denser object."

He checked the magnetometer. Was it just beginning to show a trace of a magnetic field as he approached it?

"Yes! Magnetic. This *has* to be it!" He glanced at the monitors, which showed the object so much clearer than naked human eyes could, then turned back to the window to gain a more personal connection with the planetesimal. "Eureka! Right freakin' where you're supposed to be! Sumbitch thought you were pretty sneaky, hiding out in the Oort Cloud, didn't ya? Well, Victor Gendeg tracked your banged-up ass down! Four billion years of ducking and hiding, but your ass is *mine* now, baby. I am so freakin' rich the damn Astrofellers are gonna envy me. I have *found* El Dorado!"

The solar system was young when Jupiter and Saturn migrated into a 2:1 orbital resonance. It was an interesting time for all of the other bodies there. Chaos reigned until the two giants moved beyond that dance. The two largest bodies in the system other than the Sun played tug of war in a game Jupiter won and all of the small bystanders lost.

Two of the worst losers were minor rocky planets, each with a small core of iron and other metals, and mantles that had already turned to solid stone. They were set on a collision course. It would not happen for hundreds of millions of years, but it was inevitable.

When it happened, both bodies shattered their rocky outer layers, exposing their metal cores. Pieces showered away from the impact in many directions, some into the depths of space, some into the inner system, where they would eventually meet a dramatic end. Some pelted the third planet and its moon, part of what its later inhabitants would call the "late heavy bombardment." Many simply formed a belt, shepherded into shape by resonance with Jupiter and a few other significant orbs. One of the cores stayed safely in the belt, covered in a thick layer of rubble from the collision, some its own, and some from the other unfortunate body. The other was in an elliptical orbit that flirted dangerously with the dominant gas giant. It was similarly covered with debris, and had an entourage of orbiting fragments of the same sort.

Victor waited impatiently for his small ship to maneuver to a gentle landing on the icy body. The magnetometer was unambiguous now. This ball of ice had an iron core, no doubt about it at all. Here, in one body, was everything needed to build a new city in space. A city? "Hell, I could build a whole bloody *nation* with that mutha! That thing must be as big as any core ever discovered. There must be more metal in that thing than ever was squeezed out of Earth's crust. And man, look at the ice readings. The collision must have distilled this thing like a damn refinery! Juicy, dripping, soaking damned *full* of deuterium and helium-3. I am so freakin' rich I'm gonna be the damned emperor of this god-forsaken blighted wasteland. And with medical technology today, heck, they're increasing life expectancy faster than a person ages! If you've got the money, maybe you can live forever! Imagine, Victor, the Immortal Emperor of Oort! Ah, life is *sweet!*"

He glanced at his communications panel nervously. More chatter on the net

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showed on the display. With objects out in the Cloud averaging tens of millions of kilometers apart, on the order of a light-minute, voice communications were rare. Instead, most messages were text with attachments, in the form of e-mail and forum posts. The other slackers operating out here were all gaga over the beam of radio signals coming from a couple of light-decades away. Let them waste their time.

"So what if there's somebody saying 'hi' out there? As long as it keeps their attention off me until I can validate my claim. Dumb bastards haven't got a clue where I've snuck off to. Let's take a minute or two and keep it that way." He sprang ever so gently over to his comm panel in the gravity that almost was not there, and settled in front of the keyboard.

Victor had scheduled the last stop of his flight plan as a visit to a rather boring little ball of ice that had drifted near Rendezvous 3 Station, a mere sixteen million kilometers away. The other net participants expected he would land his little explorer and have his robots bore into it and see if it held any worthwhile ices or rock dust. They would expect his communications to be sporadic, but would expect an occasional check-in. The last thing Victor wanted was a rescue party to come after him, so he left a communications relay and his transponder on the little comet, taking only enough ice from it that he could afford a long, hard blast of compressed gas to move him well away from the body. And then, when far enough away that nobody was likely to notice, he goosed the fusion reactors to a low burn, and fed a rich dose of reaction mass into the relativistic electron beam that generated his thrust, and snuck away to investigate the more distant object only he recognized as special.

Had anyone been deliberately monitoring, the ploy would not have worked. But there were only a handful of ships operating out of Rendezvous. No traffic control system was needed, and the ships generally stayed in touch voluntarily. The volume of space they explored was vast and lonely, and they had no one to depend on but each other.

"Yeah, like I figured. The idiots are all looking for little green men instead of exploring. Well, hell, guess I would too if I didn't have the discovery of a thousand lifetimes a few kilometers away. They'll probably think I'm a doofus if I don't chime in. Better read up. Huh? Crap! Well, no damned wonder they're so worked up."

Rockhound: Searcher, where you at fella? The SETI League has incoming for you.

Searcher: Just got it rockdog. Hold your horses, this is a big mutha file, and encrypted. So, let's see if I can tell you about it . . . yeah, it's not classified, they just want me to see it first. Hey, it's from Dr. SETI himself! Uh . . . holy crap, dog, the League's analysis team is actually starting to make a little sense out of that signal. It evidently contains some kind of Rosetta Stone. The trouble is, with the Rosetta Stone we knew one of the languages. With this one, they only have a vague idea of a few words because they're accompanied by pictures. WTF!?? But he says they think the transmission is—hold on to your helmet—a *religious* tract! ROFL!

Iceman: Aaargh! Just our luck! We got neighbors and they're bloody damned Reorganized Born-Again Seventh-Day Alien Evangelists!

Anybody heard from Wiener lately? That boy needs to get his head out of the ice more and look around. All this going on and all he can think about is making holes. Don't 'preciate how special this place is.

"Victor, dammit. Not Winner. Not Wiener." But Victor kept the sentiment to himself. The delight the other prospectors took in his objections to the nickname was the very reason they insisted on it.

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WIENER: I'M HERE, ICE. BEEN DOWN THE BORE FREEING A STUCK 'BOT.

ICEMAN: YOU MAKE US NERVOUS, KID. LEAVE IT, SEND IN ANOTHER ONE. UNLESS, OF COURSE, IT FOUND SOMETHING GOOD. YOU FIND SOME METAL?

ICEMAN: WIENER? WHERE'D YOU GO, BOY?

WIENER: SORRY. GOT BUSY FIXING SOMETHING AND WASN'T WATCHING THE SCREEN. ASTRONOMER METAL MAYBE, NOT ENGINEER METAL. THIS BALL OF ICE HAS ENOUGH SILICON CARBIDE IN IT TO SET UP A SANDPAPER FACTORY. IT'S EATING UP HARDWARE.

ICEMAN: SCREW THAT. THERE ARE A TRILLION OTHER TARGETS UP HERE, AT LEAST HALF OF THEM A BETTER BET. YOU BEEN OUT A LONG TIME. COME ON BACK TO RENDEZVOUS AND RUN SOME LAPS IN GRAVITY.

ICEMAN: OH WEEEE-NER? DURN, THE BOY HAS A SHORT ATTENTION SPAN.

WIENER: GOT BUSY AGAIN. I CAN'T SPARE THE 'BOT. YOU EVER TRY GETTING WARRANTY REPAIRS DONE UP HERE? I ALMOST HAVE IT FREE, JUST CAME UP FOR SOME TOOLS. LOOK, I KNOW SOME OF YOU OLD FARTS GOT NOTHING BETTER TO DO THAN STARE AT A SCREEN WAITING FOR CHAT, BUT CUT ME SOME SLACK IF I DON'T ALWAYS GET RIGHT BACK TO YOU, OKAY?

ICEMAN: UNDERSTOOD. WELL, GET BACK HERE BEFORE YOUR BONES TURN TO MUSH. OF COURSE, IF THAT HAPPENS, THAT'S A SWEET LITTLE RIG YOU FLY. I'M SURE I'LL FIND A TAKER FOR HER.

WIENER: I'M GETTING MY EXERCISE POINTS. I THINK YOU JUST WANT ANOTHER STOOL KEPT WARM IN YOUR BAR.

ICEMAN: LOL! WELL, THAT TOO. BUT TRUST ME, TUGGING ON RUBBER BANDS HALF AN HOUR A DAY AIN'T THE SAME AS GRAVITY, EVEN THE ARTIFICIAL KIND. THAT'S HOW COME I DON'T GO OUT ANYMORE, I WAS SCREWING UP MY WHOLE MUSCULAR-SKELETAL WHO-HAH. THE CLOUD HAS BEEN HERE A THIRD THE AGE OF THE UNIVERSE. IT'LL KEEP. NO GOOD STRIKING IT RICH IF YOU'RE NOTHING BUT A SACK OF RUBBER. COME ON BACK WHEN YOU GET A CHANCE AND WE'LL ALL RAISE A TOAST TO GETTING A PHONE CALL FROM ET.

WIENER: I WILL SOON, BUT I'VE GOT BILLS TO PAY. C U LATER.

The core made thousands of orbits before the fateful encounter. It finally came too close to Jupiter. The giant tugged on it, changing its direction. The hundreds of tiny pieces of debris orbiting the core swung off into a spiral string of pearls, but generally tagged along behind the larger body, as it made one final loop around the gas giant. The next pass was very close, nearly a plunge into the deep atmosphere and oblivion. Instead, it swung sharply around the ponderous planet, and, like a skater grabbing a handle on a moving Zamboni, changed its direction. It acquired more velocity in the direction of Jupiter's orbit, but also was pitched to an angle above the ecliptic. In this maneuver, two things happened. First, the core acquired more speed, almost enough to escape the Sun's gravity entirely. Second, the huge tidal forces tugged at the covering of debris. Some pieces came free, and the core acquired spin as the resulting imbalance swung into the steep gradient of Jupiter's gravity well. As it departed the big planet, more and more pieces of rock flew off from the equator, and other pieces tumbled to replace those lost. Some of the escapees crashed back to the surface, knocking off more pieces. Others escaped the feeble gravity of the core and began spreading out from it. All were heading in roughly the same direction, toward the cold, dark, almost empty outer reaches of the solar system.

Victor could barely contain his excitement as the ship settled the last few meters to the surface of the icy planetoid, and held his breath as he felt the soft crunch of the pads settling into the texture of old snow. While the computer ran the shutdown sequence, he turned to the robot panel and made ready to deploy a borebot.

In minutes, the intelligent drill head was grinding its way into the ice. As it went, it heated the spoil, vaporizing the

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most volatile gasses and using them to blast the snowy spoil out via a flexible duct. The solid portion of the spoil was ejected out over the surface of the body, and made an unusual ballistic snowstorm in that direction. Part of the snow would eventually circle the planetoid and shower the ship with a gentle dusting of white flakes. The resulting ring would eventually be visible, but by that time, Victor's claim to the object would be solid. Some of the gas was processed through a permselector. The valuable deuterium and helium-3 were saved, along with samples of the less volatile materials. Victor studied the analyses with greedy eyes.

"Good stuff. Sweet stuff. Some tar on the surface and the usual mix of dust, but so far this one is mostly ice. Easy digging, but we'll probably hit harder ice soon. Long way to go to the core. Oh, mama would have been so proud! Her boy's gonna be the richest mutha in the system."

An audio annunciator on the 'bot panel beeped to indicate the borebot had just passed one hundred meters of depth. Victor tossed his head in mirth. "Oh yeah? Well, you're probably right, I am a potty-mouth. But you don't mind, do you? You've been with prospectors before. No, I don't always talk like this, usually just when I'm alone."

A hydraulic cylinder in the belly of the ship groaned a little as it adjusted to the increasing load. Victor grinned. "Oh, you think you count as company, do you? Now you want to be my friend, now that I'm the richest son of a bitch since this core's brother was found. Hell, probably richer'n that, because that rock was so freakin' dry it made the Sahara look soggy. Yeah, now everybody will want to be Victor Gendeg's buddy. But you? Well, I don't even own you. You're leased. I guess that makes you a whore, doesn't it? A lousy damned painted lady whose pimp rents her out to any prospector that shows a fancy to her. You do realize the second thing I gotta do when we get back, right after I file my claim, is get my hooks in a bigger ship, don't you?"

A pressure regulator hissed back in the life support system as it replenished itself with comet gas.

"Well, don't worry, you're a pretty little thing. Maybe I'll make Ice an offer, and keep you anyway. Maybe I'll build me a palace and put you up on top as a spire, and come up here and look out the windows and survey my empire."

He glanced at the analyzer. "Mmmm, interesting little pocket. Olivine, plus some boron and aluminum. I do believe this ball of junk has got a little of everything. But we're nowhere near the good stuff."

Victor opened a drawer and extracted a cushioned sack, from which he drew a curious piece of material, half rock, half metal. "Computer, cabin video log on. Hello, little buddy, do you know where you are? I think we just found your mama. And we couldn't have done it without you!"

With his free hand, he slipped his sippy-cup into a water dispenser. "We now have fresh water from El Dorado. Time for a toast." He removed the cup from the dispenser, tipped it, and opened the valve. A small blob of water formed, which he shook loose. It dropped gently toward the flake of asteroid. "You get the first taste." When the drop hit the stone, he put the cup to his lips and took a sip, then grimaced a little. "Ugh, needs more dissolved oxygen, and maybe a touch of whiskey. But it is now official, little friend: We're one with El Dorado."

The core sailed out into the dark reaches of the solar system, out into the freezing realm where ice, not rock, dominated. But the distance between the icy bodies was so great that the space might as well have been empty. The original string of tiny moons that accompanied it to Jupiter had long since drifted far away. Thousands of

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the pieces of rubble that had been stripped from its surface still tagged along, most no larger than a pebble. It had now lost most of its velocity, but the tug from the star that had fostered its birth was all but gone as well. Had it picked up just a little more kinetic energy from its last encounter with Jupiter, it would have sailed into interstellar space. Instead, it arched slowly amid the scattered ice, reached a near standstill, and then turned and headed back in. An invisible trace of frost covered the core and its companions on that first million-plus-year foray into the Oort Cloud.

But after two thousand passes, the frost was significant. And with each return to the inner system, the frost melted and found its way into cracks. And on each return to the icy darkness, the moisture froze again, a little deeper inside. Eventually the ice freed pieces entirely, although they lay where they were in the tenuous gravity. And once in a while, during a pass through the inner system, or after the rare impact of a tiny fragment of comet, one of those pieces would be ejected from the surface. These often joined the entourage of small bits and pieces orbiting the core. They replenished that population, as other pieces were nudged further away by continued gravitational encounters.

The core was leaving a trail of breadcrumbs to follow.

"Look at this thing!" Victor held the odd stone up as if to show it to the ship. "You got any idea what this thing is? This, my new tin friend, is the key to a treasure chest. One of many, but an important one. That hunk of iron down in this ice ball is the largest piece left of a little planet that got smashed all to crap about four billion years ago. Folks have found pieces of this thing all the hell over the solar system. Pieces of it formed some of the craters on the Moon. They've found chunks on Mercury, Mars, and every moon of every outer planet except Pluto, which is okay since Pluto is not a planet this month. The asteroid belt is *lousy* with it. Lots of pieces in Jupiter's Trojan points, too. But the neat thing, the really neat thing, is that there are pieces of it zipping in and out of the Oort cloud.

"You're in the prospecting business. You've been a prospector's painted lady before. You know that everybody out here wants to find metal, the good engineering kind, and 'tain't much to be found. No, granted, a little piece like this, with only a few hundred grams of iron globbed on one side, is not going to build many fleets. But little pieces like these are clues to where the big pieces are. They're so important, the government gives grants to guys like me to track them down and figure out their history.

"I found this little piece coming in from the cloud to the inner system. I had a pretty good idea of where to look because of where all the other pieces have been found. One look at this rock, and every expert identified it as a flake off the core/mantle interface. A little analysis of the cosmic ray damage to the faces tells us about how long ago it came off the core. That narrowed down the time when we know the core was still orbiting freely. And nobody was finding any younger pieces.

"It has been no big secret that all these pieces came from the same parent, and that it must be looping thru the Oort Cloud. People have been back-calculating the trajectories for decades, hoping to figure out exactly where it is. They've worked out just when each close star pass occurred; all the interactions with the inner planets and ice giants; they've even figured exactly when—3.748212 billion years ago—this thing crossed Jupiter's path once too often and got pitched out of the inner system. We know where it ought to be; close enough that a radar search should turn it up. But it's not there.

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"So I got to asking myself, how could a big iron cannonball that ought to reflect radar like nobody's business just vanish? Everybody else was looking for missing perturbations in the orbital mechanics. Me, I realized most of those supposed perturbations were too small to matter. The orbital period of this core was a little over a million years, so it didn't have but a few thousand passes thru the inner system, and we have the perturbations in the inner system nailed down. The Oort Cloud isn't chaotic, it is wonderfully predictable. Once we got all the close star passages cataloged, and mapped all the ice giants, the chances of a missing perturbation started getting pretty small. The fragments, like this one, were all coming in where they should be. There was no missing perturbation. So I started looking for the event that was so unlikely, nobody seriously considered it. The possibility that the cannonball hit a snow bank way out here somewhere.

"There's another class of fragments folks are very interested in. The folks living down in the asteroid belt need volatiles as badly as the folks out here need metal, only there are a whole lot more people in the belt. So what do they do? They chase down the little minor comets that scream through on a regular basis. And what do they find? Lo and behold, a lot of the little comets come from common parents, too. But, comets are a different department, and nobody seemed to make the connection.

"So all I had to do was look up the database of all the comet fragments and their extrapolated parents, compare that to the possible orbits of the core, and figure out where the collision could have taken place. And I got a match, but it was nearly a billion years ago. I couldn't know exactly what happened in the collision, but I did know what direction the core hit from. The comets had all radiated on that same heading, and that told me it was a dead-center hit. Because of that, I knew what range of changes would occur in the orbit of the object that was hit. I knew that the resulting object would be denser than in should be, a couple of oddball orbital parameters that gave me a belt in which it could reside, what class of object it was, and that it should show evidence of a particular type of hit. That narrowed the possibilities down to a few thousand known bodies. Looking at those, I could see if their masses fit the oddballness of those orbital parameters. That got me down to a few hundred candidates."

The ship's plumbing gurgled as it switched the flow of liquid gas from a full storage tank to one that was empty. Victor grinned and nodded.

"What led me to this one? Simple, really. Two of the best candidates were closest to this outpost. I could afford to reach it."

He looked at the clock. "I'd better ping the net so they know I'm still alive."

Searcher: Okay, guys, Dr. SETI just sent a new update on the translation. I'm starting to get just a little alarmed. The Little Ferry team still thinks it is a religious tract, but it doesn't sound like they're trying to convert us. More like hellfire and damnation. They've managed to translate a few phrases. One seems to translate roughly as "corruption of creation." Another is "look this way" followed by something they can't make out, then "see your damnation." Near the end of the message they say, "consumed in fire."

Rockhound: I used to have a neighbor that tended to say stuff a lot like that when I was a kid.

Iceman: Well, as long as they're over there and we're over here, I'm not too worried.

Frosty: Frosty checking in. I'm heading back with a full load of volatiles but nothing special. Man, all my life I've wanted to get a call from ET. And now he tells us to go to Hell? What did we ever do to

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HIM?

ROCKHOUND: HEY, FROST, GOOD TO HEAR FROM YOU. MAYBE OLD ET HAS BEEN PICKING UP OUR TELEVISION BROADCASTS. EVEN I FIND SOME OF THOSE PRETTY OFFENSIVE.

WIENER: WIENER CHECKING IN. MAMA TOLD ME NOT TO ARGUE ABOUT RELIGION, SO I'LL STAY OUT OF IT. I'LL BE FILING A CLAIM WHEN I GET IN. OUT.

ICEMAN: WE'LL BE LOOKING FOR YOU, KID. DECIDED TO OPEN THAT SANDPAPER FACTORY AND SETTLE DOWN?

SEARCHER: ANY OF YOU GUYS EVER DO THE CALCULATIONS ON HOW FAR OUT YOU COULD PICK UP A BROADCAST TELEVISION SIGNAL? IT'S PRETTY DISMAL. AT TWENTY LIGHT-YEARS, YOU'D NEED THIS HUGE HIGH-GAIN ANTENNA ABOUT THE SIZE OF A PLANET, AND IT WOULD HAVE TO BE DIRECTED STRAIGHT AT US, SCANNING A BROAD RANGE OF FREQUENCIES. AND YOU STILL PROBABLY COULDN'T EXTRACT ANY INFORMATION FROM THE SIGNAL. WE SETIZENS HAVE BEEN LOOKING FOR A SIGNAL LIKE THAT FOR OVER A CENTURY. EVERY FEW DECADES WE PICK UP A SNIPPET OF SOMETHING THAT LOOKS LIKE A SIGNAL AND THERE'S A LITTLE EXCITEMENT, BUT WE'VE NEVER GOTTEN ANYTHING CLEAR, CONTINUOUS, AND UNAMBIGUOUS. NOT UNTIL THIS SIGNAL CAME BLASTING IN. I'M WONDERING IF MAYBE THEY PICKED UP OUR RADAR PINGS, FROM ALL THE MAPPING WE'VE BEEN DOING OUT HERE.

ICEMAN: SO HOW COME THIS IS SO STRONG IF OURS WOULD BE SO HARD TO DETECT?

SEARCHER: BEST GUESS, THEY'VE GOT A HIGH-GAIN ANTENNA THE SIZE OF A PLANET POINTED AT US, AND THEY'RE CRANKING A FEW BILLION WATTS OUT OF IT. AND WE'VE GOT A BUNCH OF DECENT-SIZED DEEP-SPACE ANTENNAS POINTED AT EVERY HABITABLE-LOOKING STAR WITHIN ABOUT SEVENTY LIGHT-YEARS, WITH SOME FAIRLY SOPHISTICATED LISTENING EQUIPMENT ON EACH ONE. WE DON'T KNOW WHAT THEY DETECTED, BUT THERE IS NOT MUCH DOUBT THE MESSAGE IS MEANT FOR US, BECAUSE IT IS DEFINITELY BEING BEAMED STRAIGHT AT US. BIG PART OF MY MISSION IS TO COMPARE SIGNAL STRENGTH HERE TO MEASUREMENTS WE ARE GETTING AT THIS DISTANCE AT RIGHT ANGLES. ITS COMING RIGHT DOWN OUR THROATS HERE IN THE VICINITY OF RENDEZVOUS, STRAIGHT FROM THAT LITTLE YELLOW STAR OVER YONDER, RIGHT TOWARD OUR LITTLE YELLOW STAR, WITH THIS OUTPOST RIGHT ON THE LINE, GIVE OR TAKE A FEW HUNDRED MILLION KILOMETERS.

ROCKHOUND: STILL SOUNDS LIKE MY NEIGHBOR. IT SEEMED TO OFFEND HIM THAT WE JUST EXISTED.

SEARCHER: LATEST UPDATE. THEY DECIDED TO TAKE "LOOK THIS WAY" LITERALLY. THEY CALLED SOME FRIENDS AND PUT A BIG TELESCOPE ON IT, AND THEY SEE A NEW CLASS OF OBJECT THEY CAN'T UNDERSTAND, RIGHT IN THE GLARE OF THAT STAR THE SIGNAL IS COMING FROM. VERY HOT GAMMA RAYS. THEY'RE ASKING TO GET ONE OF THE LARGE DEEP-SPACE ARRAYS TRAINED ON IT TO SEE IF THEY CAN GET A BETTER LOOK. CALL ME PARANOID, BUT I'VE GOT THIS CREEPY FEELING THAT MAYBE ET HAS LAUNCHED SOME KIND OF DOOMSDAY WEAPON. A BIG BALL OF ANTIMATTER MAYBE? IT SOUNDS LIKE IT IS PRETTY FAR OUT, BUT WHO KNOWS? GUYS, I'D LIKE YOU TO BE READY IN CASE THEY ASK US TO DO SOMETHING LIKE SETTING UP TO TAKE MEASUREMENTS OR EVEN MOUNT SOME KIND OF DEFENSE.

ROCKHOUND: COUNT ON ME.

ICEMAN: RENDEZVOUS 3 STATION IS AT YOUR DISPOSAL.

VIOLET: VIOLET CHECKING IN. YOU BOYS KNOW I ALWAYS DO WHATEVER I'M ASKED.

FROSTY: ANYTHING YOU NEED, ASK.

CRUSTY: CRUSTY CHECKING IN. I'M PRETTY FAR EAST. YOU HAVE MY COORDINATES IN CASE I'M IN A POSITION TO DO ANYTHING.

STINKY PETE: STINK CHECKING IN. I'M NORTH A COUPLE OF AU. AT YOUR DISPOSAL.

SEARCHER: I'M TRANSMITTING THE ENCRYPTION KEY FOR THE SETI LEAGUE MESSAGES. I HEREBY MAKE YOU GUYS HONORARY MEMBERS. FEEL FREE TO READ MY MAIL.

The core passed thru the Oort cloud nearly three thousand times before it crossed paths with an ancient, pristine, primordial snowball. The icy body was large, sufficiently so to be round and to have formed differentiated layers. It might arguably pass as a Pluto-class dwarf planet by some definitions. It was about to change to a classification all its own.

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Neither body was moving especially fast relative to the other, and their feeble gravities accelerated the approach only a little. The collision was gentle by astronomical standards. The core plunged into the snowball virtually dead on, lodging near the center. Displaced ice propagated ahead of the core, and ejected a shower of icy chunks on the opposite side, much as a bullet hitting a ripe melon might eject a spray at the exit wound. The remaining energy of the collision became heat, not a great amount, but to a body used to hovering near absolute zero, it was like being stabbed with a hot poker. Gas spewed from the fissures as the material around the core melted and boiled.

The object froze again within a few millennia, preserving scars that would be unchanged in a billion years.

Victor crosschecked the readings from the borebot with those from probes he had dispatched to orbit El Dorado. Despite an unexplained background neutrino noise, he could tell exactly where the core was, and it was a beauty. The ice it was buried in was a bonus, not a nuisance, for, although volatiles were relatively plentiful in the Cloud, the distance between bodies was hardly trivial, and nobody likes to haul water from a distant well. Some miners liked the shielding deep ice provided.

The borebot was nearing the core, grinding through hard ice that now produced odd pieces of rock and metal. He slowed its pace as the sensors indicated that there were only a few meters to go. The sampling instruments displayed a forest of new peaks.

"EDS shows iron, nickel, aluminum, copper, yada, yada, gold, silver, platinum, the works! It's like getting a chemistry set for Christmas. I am so disgustingly *rich.*"

The robot panel beeped and he looked at the display. "Starting to make contact. Okay, stop boring and just clean up with the lasers. Nice and easy."

The borebot finished exposing the metallic core, then backed off to allow the surface to be imaged. Victor studied the image proudly, his eyes glancing to the piece in his hand for comparison. The texture was amazingly similar. The shape . . . His eyes focused on one spot of the borebot's field of view, and he leaned closer to be sure. He traced his finger around one feature of the image.

"Borebot two, zoom image to the indicated area. Scan holographically. Okay, now cut a forty centimeter core at the indicated position, depth ten centimeters, and transport it to the surface."

He held the piece in his hand up at arm's length, and compared it again to the image. "Can't be. That would just be too weird for words."

Searcher: All net alert! The latest translation is in. "Corruption of creation, abomination of the Word, look this way. The hydrogen sucking light-chaser comes. See your damnation approach, unstoppable. You are to be consumed in the fire of your own star. Our obligation to warn is fulfilled. Prepare to die." The SETI League says they are now checking with everyone they know to see if "hydrogen-sucking light-chaser" might mean a Bussard Ramjet.

Violet: So you were right. They did launch something at us. Do you suppose they can actually target Earth from that far away?

Iceman: Oh, nice. They're genocidal maniacs, but at least they're ethical!

Rockhound: What's this about a Bussard Ramjet? I thought those were just *science fiction gadgets.* And I *think* I also read that the idea would not work. Something about excessive drag.

Searcher: Negative, Rockdog. According to my database, the idea was published by Dr. Robert W. Bussard in 1960, in a scientific journal called *Astronautica Acta.* Back in the last millennium, there were a few papers on flawed designs that couldn't work, but there is still serious work going on in the field. Give me a min-

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UTE TO READ THIS.

ROCKHOUND: I LIKE YOUR ANTIMATTER IDEA BETTER.

SEARCHER: ROCK, THE LATER STUDIES DETERMINED THAT THE DRAG OBJECTION CAN BE OVERCOME IF THE ENGINE DOES NOT ACTUALLY BRING THE HYDROGEN UP TO SHIP SPEED. A WORKABLE VERSION WOULD USE RELATIVISTIC FLOW DYNAMICS TO COMPRESS THE FUEL EXTERNAL TO THE SHIP AND CAUSE IGNITION, SOMETHING LIKE A SCRAMJET.

ROCKHOUND: SO WHY HAVEN'T WE BUILT ONE?

SEARCHER: WE STILL DON'T KNOW HOW TO BUILD A REACTOR THAT FUSES ORDINARY HYDROGEN TO PRODUCE USEFUL ENERGY.

ICEMAN: WHAT ARE WE LOOKING FOR AND HOW DO WE STOP IT?

ROCKHOUND: WHAT ABOUT ANTIMATTER? WOULDN'T AN ANTIMATTER ROCKET ALSO "CHASE LIGHT"?

SEARCHER: I'VE GOT ANOTHER MESSAGE COMING IN. ROCK, AN ANTIMATTER ROCKET STILL OBEYS THE ROCKET EQUATION. TO APPROACH LIGHT SPEED AS CLOSELY AS A RAMJET CAN, THE FUEL TO PAYLOAD MASS RATIO WOULD HAVE TO BE PHENOMENAL, AND THE PROJECTILE WOULD BE A FEATHERWEIGHT BY THE END OF THE FLIGHT. A RAMJET WOULDN'T LOSE MASS; IN FACT RELATIVITY SAYS IT *GAINS* MASS. MAYBE A LOT OF IT. BUT THERE'S ALSO A HYBRID DESIGN, ONE THAT USES ANTIMATTER FUEL BUT SCOOPS UP HYDROGEN TO REACT AGAINST IT AND SERVE AS REACTION MASS.

ROCKHOUND: THERE YOU GO; MAYBE WE'RE BOTH RIGHT. BESIDES, WITH ANTIMATTER, IT DOESN'T MATTER IF IT IS GOING FAST, IT'S JUST BAD NEWS IF IT TOUCHES YOU.

SEARCHER: OKAY, THE NEW MESSAGE IS IN. THE ABSTRACT SAYS THEY HAVE CONFIRMED THAT THE SPECTRUM OF THE NEW OBJECT IS CONSISTENT WITH BROADBAND THERMAL EMISSIONS, IONIZED HYDROGEN, AND ELECTRON/POSITRON ANNIHILATION, BLUESHIFTED TO 0.992 C.

ROCKHOUND: I HATE TO SAY I TOLD YOU SO, BUT SEE, ANTIMATTER! IF WE CAN SEE IT, WE SHOULD BE ABLE TO STOP IT. ANY CHUNK OF MATTER WOULD DO THE JOB.

SEARCHER: POSITRONS DON'T NECESSARILY MEAN IT'S AN ANTIMATTER PROJECTILE. PROTON-PROTON FUSION WOULD HAVE TO BE THE FIRST STEP IN USING PLAIN HYDROGEN FOR PROPULSION, ASSUMING THEY USE FUSION AT ALL. MOST OF THE USEFUL ENERGY FROM P-P FUSION IS FROM A POSITRON THAT IS EMITTED WHEN ONE PROTON CHANGES TO A NEUTRON. AND READ MY TRANSMISSION AGAIN . . . THAT'S 99.2% OF THE SPEED OF LIGHT! I THINK THAT THING IS AN INTERSTELLAR RAMJET. AND I'M NOT SURE WE *CAN* STOP IT. GIVE ME A MINUTE OR TWO TO DO SOME NUMBER CRUNCHING.

ROCKHOUND: YOU CRUNCH, I'LL CATCH UP ON MY RAMJET READING.

SEARCHER: YEAH, JUST AS I FEARED. LET'S SAY WE CAN SEE THIS AS A TINY SPECK AT ONE LIGHT-YEAR AWAY. AT THAT SPEED, IT WOULD BE LESS THAN THREE DAYS BEHIND THE LIGHT. IT IS A LOT CLOSER THAN IT APPEARS. A *LOT!* I DON'T THINK THERE WOULD BE TIME TO REACT. DAMNATION, THIS INFORMATION IS AT LEAST 3.3 DAYS OLD DUE TO THE TRANSMISSION TIME. WE'RE CLOSER TO THIS THING THAN EARTH, BUT WE'RE WORKING ON OLD DATA.

ICEMAN: HOW FAR AWAY ARE THEY SEEING IT WITH THAT BIG TELESCOPE?

ROCKHOUND: IS THAT THE TELESCOPE THEY'VE BEEN USING TO SPOT EARTH-SIZED PLANETS AROUND STARS?

SEARCHER: THEY DON'T HAVE A DISTANCE YET, BUT IF IT REALLY IS GOING THAT FAST, IT WILL APPEAR TO GET BRIGHT FAST. MAYBE WE DON'T NEED A TELESCOPE WITH A 10-KILOMETER APERTURE ANY MORE. EVERYBODY, YOU KNOW THE STAR WE'RE GETTING THE TRANSMISSION FROM. PUT YOUR TELESCOPES ON IT AND SEE IF YOU SPOT SOMETHING THAT SHOULDN'T BE THERE. I KNOW ALL YOU PROSPECTORS HAVE FANCY SPECTROMETERS. CAN ANY OF YOU PICK UP HOT GAMMAS?

ICEMAN: THE STATION CAN. I KNOW WIENER'S SHIP HAS A GAMMA SCOPE, TOO, BECAUSE I INSTALLED IT MYSELF. I'M ON IT.

FROSTY: I HAVE IT ON MINE.

VIOLET: I HAVE THAT CAPABILITY. I'LL HAVE A LOOK.

ROCKHOUND: MINE'S BROKEN BUT I THINK I CAN FIX IT. SEARCHER, IF THE RAMJET IS ACCELERATING FOR THE WHOLE FLIGHT, THAT MEANS IT ISN'T GOING AT A CONSTANT SPEED FOR THAT WHOLE LAST LIGHT-YEAR. IT WOULD ACTUALLY BE GOING FASTER NOW. THERE WOULD BE LESS

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TIME THAN YOU THINK.

SEARCHER: I HOPE YOU'RE WRONG, ROCK, BUT YOU'RE ALMOST CERTAINLY RIGHT, AND WE BETTER PLAN THE FASTEST RESPONSE WE CAN SCRAPE TOGETHER. WE GOTTA GET A HEAD START ON THE DATA. I'VE BEEN LOOKING AT MY DATABASE, AND HERE'S WHAT I FIND. THIS JUST NUMBS MY MIND. BUSSARD'S OWN ANALYSIS OF THE RAMJET CONCEPT SAID IT WOULD PROBABLY MAX OUT AT ABOUT 99.9999% OF LIGHT SPEED. CAN YOU GET YOUR MINDS AROUND THAT NUMBER? LET'S BET THAT IS WHAT IT WILL BE DOING WHEN IT GETS HERE. HE ALSO DID A SPECULATION THAT A REALLY BIG RAMJET, AT THAT SPEED, COULD BE USED TO TRIGGER AN EXPLOSION OF A *STAR,* NOT JUST A PLANET. LET ME READ PAST THE ABSTRACT.

STINKY PETE: STINK CHECKING IN. I GOT TELESCOPES FROM LONG WAVE IR TO HOT GAMMA. THE GAMMA'S ONLY A HALF-METER APERTURE THOUGH.

ICEMAN: ANYBODY HEAR FROM WIENER? HE'S THE ONLY ONE WHO HASN'T CHECKED IN. HIS GAMMA SCOPE IS A POINT-EIGHT METER WITH A REALLY GOOD DETECTOR.

FROSTY: I GOT A HOT GAMMA PINPOINT ON MY SCOPE ABOUT WHERE WE'RE LOOKING. REALLY DOWN IN THE NOISE AND NOT GOOD ENOUGH FOR A SPECTRUM YET. WHAT WAVELENGTHS WOULD WE SEE?

VIOLET: I THINK I JUST SPOTTED IT. VERY FAINT. I WOULDN'T HAVE NOTICED IT IF SOMEBODY DID NOT TELL ME IT WAS THERE. DO WE HAVE A TRAJECTORY YET?

SEARCHER: I'M SPEED-READING. HOPE I DON'T MISS ANYTHING IMPORTANT. BUSSARD'S SPECULATION WAS THAT AT FULL SPEED, THE RAMJET WOULD HAVE WHAT HE CALLED A FOUR-DIMENSIONAL TIME-ABLATION SHIELD. WHAT THAT MEANS IS BASICALLY THAT TIME IS MOVING SO SLOWLY ON THE RAMJET THAT IT DOESN'T EVEN KNOW IT HAS HIT A STAR UNTIL IT HAS PENETRATED ALMOST TO THE CORE, TO ABOUT 0.02 OF THE STAR'S RADIUS FROM THE CENTER. THE SHIP HAS ESSENTIALLY BEEN CONVERTING ENERGY INTO EQUIVALENT MASS EVER SINCE IT STARTED APPROACHING THE SPEED OF LIGHT, SO THE ENERGY RELEASED WHEN IT FINALLY VAPORIZES IS STUPENDOUS. STARS WORK BECAUSE THEY HAVE VERY STABLE STEADY-STATE COMPRESSION FORCES BALANCED AGAINST RADIATION PRESSURE WORKING ON THEIR CORES, WHERE THE FUSION IS ACTUALLY TAKING PLACE. AN EXPLOSION OF THIS MAGNITUDE TOTALLY SCREWS UP THIS BALANCE. BUSSARD CALCULATED THE EFFECT OF THE RAMJET EXPLODING WOULD BE TO OVERHEAT A LARGE LOCAL AREA OF THE CORE, WHICH WOULD ESSENTIALLY UNDERGO SOMETHING LIKE A SUPERNOVA IMPLOSION. THAT, IN TURN, BLOWS UP THE STAR. A WEAPON LIKE THAT WOULDN'T JUST KILL EARTH, IT WOULD KILL EVERYTHING IN THE WHOLE SOLAR SYSTEM!

DAMN, THESE GUYS MUST REALLY HATE US.

ROCKHOUND: DAMN BUSSARD TO HELL FOR DREAMING THAT THING UP!

SEARCHER: ROCK, JUST A GUESS, BUT I'D BE WILLING TO BET GOOD MONEY THAT BUSSARD NEVER VISITED THE STAR SYSTEM THAT LAUNCHED THIS THING. IF NOBODY HAD DREAMED UP THIS IDEA, HOW WOULD WE EVER REALIZE WHAT THAT THING WAS AND MAYBE HAVE A CHANCE TO STOP IT? AND FURTHERMORE, IT TURNS OUT HE'S THE GUY WHO INVENTED THE P-B^{11} POLYWELL REACTOR THAT RUNS YOUR SHIP, AND WE MIGHT NOT EVEN BE UP HERE WITH A CHANCE TO DO ANYTHING IF NOT FOR HIM.

ICE, YOU ASKED HOW TO STOP IT? BUSSARD FIGURED A 200-KM ASTEROID IN THE PATH OF THE THING OUGHT TO DO THE TRICK, IF YOU COULD INTERCEPT IT FAR ENOUGH OUT. THAT SHOULD DESTROY THE SHIP ITSELF, ALTHOUGH I SUSPECT THE FRAG COMING OFF THE COLLISION WOULD NOT BE TOO PEACHY TO BE AROUND.

ICEMAN: ASTEROIDS ARE IN SHORT SUPPLY OUT HERE, SEARCHER. WOULD AN ICE BALL OF EQUIVALENT MASS DO THE JOB? THE TROUBLE IS, THERE ARE ABSOLUTELY NO MASS DRIVERS OUT HERE LIKE THEY USE TO MOVE ASTEROIDS WITH. LET'S SEE, AN ASTEROID LIKE THAT WOULD BE, SAY, 5×10^{18} KILOGRAMS. SO, LET'S SAY WE HAVE 24 HOURS, FROM A STANDING START, YEAH, WE MIGHT MOVE A BODY OF THAT MASS ABOUT HALF ITS DIAMETER IF WE REDLINED THE REACTORS AND PUMPED REACTION MASS FROM THE BODY ITSELF.

SEARCHER: I'M HAVING A BRAIN FART GUYS. HONESTLY, I JUST PASSED GAS AND IT GAVE ME A WILD IDEA. AN INTERSTELLAR RAMJET IS DESIGNED TO COLLECT INTERSTELLAR HYDROGEN, AT SOMETHING LIKE MAYBE ONE ATOM PER CUBIC CENTIMETER, RIGHT? AND HYDROGEN IS AC-

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TUALLY A PRETTY PATHETIC FUSION FUEL. IT IS HARD TO LIGHT OFF, IT'S THE REACTION RATE LIMITER IN STARS, AND IT ONLY PRODUCES ABOUT 1 MeV OF USEABLE ENERGY FROM THAT POSITRON. THE SAME SHOULD BE TRUE OF THE RAMJET. THE DEUTERIUM-DEUTERIUM FUSION CHAIN MAKES ABOUT 27 TIMES THAT, AND IT LIGHTS OFF A HELL OF A LOT EASIER! WE'VE GOT DEUTERIUM, AND WE CAN MOVE IT RELATIVELY QUICKLY. SO ANYBODY HERE UP TO CALCULATING WHAT WOULD HAPPEN WHEN YOU PUT A HUNDRED TONS OF DEUTERIUM, AND MAYBE SOME HELIUM-3 FOR GOOD MEASURE, AT MAYBE A MILLION TIMES THE DENSITY OF INTERSTELLAR HYDROGEN, IN THE PATH OF A MACHINE DESIGNED TO EAT AND BURN INTERSTELLAR HYDROGEN?

ICEMAN: SO YOUR HOPE IS THAT THE COLLECTION SYSTEM WILL DIRECT THAT SLUG OF FUEL INTO THE SHIP ITSELF, AND SET IT OFF? YOU'RE PROBABLY OVERSTATING THE YIELD A LITTLE SEARCHER. I SUSPECT ONLY THE FIRST STEP IN THE CHAIN WILL OCCUR. THE PROMPT D-D REACTION WOULD ONLY PRODUCE ABOUT THE ENERGY OF . . . 2000 MEGATONS OF TNT. YEAH, THAT MIGHT JUST DO THE TRICK. IT WOULD BE LIKE DUMPING A LITER OF LIQUID NITROGLYCERINE INTO THE AIR INTAKE OF AN INTERNAL COMBUSTION ENGINE, TIMES TWO TRILLION OR SO.

SEARCHER: LET'S HOPE IT'S ENOUGH. I'M TRYING TO COMPREHEND THE MASS AND ENERGY OF THAT RAMJET. THE DEUTERIUM EXPLOSION MIGHT BE NO MORE THAN A HICCUP IN COMPARISON.

ICEMAN: YOU MAY BE RIGHT. WE'RE THINKING NEWTONIAN PHYSICS. BUT IN RELATIVITY, $F = m \cdot a$ BECOMES $F = \gamma^3 \cdot m \cdot a$. γ IS THE LORENZ FACTOR, WHICH AT 0.999999 C IS 707. CUBING IT GIVES 3.536E+08. IT IS OVER 350 *MILLION* TIMES HARDER TO AFFECT THIS THING'S SPEED THAN IT WOULD BE AT LOW VELOCITY! NO WONDER BUSSARD FIGURED IT WOULD TAKE SUCH A LARGE OBJECT TO KILL THIS THING.

ROCKHOUND: I BELIEVE WE'RE ALL FLYING MARK III EXPLORERS. THE RESCUE POD IS THE WHOLE COCKPIT, COMPUTERS AND ALL. THE SHIP IS BRAINDEAD WITHOUT IT. WE CAN'T SET UP AN UNMANNED MISSION UNLESS WE CAN MAKE IT BACK TO RENDEZVOUS FIRST.

SEARCHER: THERE'S NO TIME ROCK. AND I THINK IT WOULD TAKE A MONTH TO PROGRAM THESE SHIPS TO DO A RELIABLE AUTOMATED INTERCEPT. ANYBODY GOT ANY QUESTIONS ABOUT THE MATH?

ICEMAN: TWENTY-ONE BILLION SOULS IN THE INNER SYSTEM, EIGHT OF US OUT HERE. DOESN'T TAKE A ROCKET SCIENTIST TO FIGURE THAT MATH OUT, SEARCHER. I JUST FOUND SOMETHING IN MY DATABASE. IT TURNS OUT THAT AN OUTFIT CALLED DRAPER LABS TOOK A SERIOUS LOOK AT THE RAMJET WEAPON IDEA. THEY CALCULATED THAT THE THING CAN'T TURN WORTH CRAP. IT HAS TO BE LOCKED ONTO ITS FINAL TRAJECTORY FROM SOMEWHERE BETWEEN 1 AND 1.5 PARSECS BEFORE IMPACT. THAT'S A MINIMUM OF 3.3 LIGHT-YEARS. WE'VE GOT THAT GOING FOR US. IF WE CAN DETERMINE ITS TRAJECTORY INSIDE THAT RANGE, WE CAN BET IT WILL STAY ON IT.

ROCKHOUND: SAYS HERE THE SHIP MAY NOT BE A BIG TARGET, BUT IT COLLECTS FUEL BY PROJECTING A FIELD OUT IN FRONT OF IT, SORT OF A FUNNEL. THE WIDER THE FUNNEL, THE MORE AREA IT SWEEPS, THE MORE FUEL IT CAN GATHER. I'M SEEING ALL SORTS OF ESTIMATES FOR THE DIAMETER OF THE FIELD, BUT THIS RAMJET NEEDS TO BE VERY LARGE TO BE A STAR-KILLER. IT NEEDS ABOUT TEN SQUARE KILOMETERS OF SCOOP AREA FOR EVERY TON OF REST MASS OF THE SHIP. LET'S SAY IT IS AS MASSIVE AS AN OLD BATTLESHIP, MAYBE 60,000 TONS, THAT WOULD MAKE THE SCOOP DIAMETER SOMETHING LIKE 860 KILOMETERS. I KNOW THAT'S NOT VERY BIG COMPARED TO DISTANCES OUT HERE, BUT IT'S BETTER THAN HAVING TO HIT SOMETHING THE SIZE OF A SHIP, EVEN A BIG SHIP.

SEARCHER: GOOD FIND ROCK. IF YOU'RE RIGHT, THAT MEANS THE RAMSCOOP WAS DESIGNED TO PICK UP LESS THAN A KILOGRAM PER SECOND OF HYDROGEN IN INTERSTELLAR SPACE. A FULL PAYLOAD OF DEUTERIUM WILL DEFINITELY BE MORE ENERGY RELEASE, PROBABLY IN JUST MICROSECONDS, THAN IT WAS DESIGNED TO PROCESS.

VIOLET: FOLKS, THE FUEL HAS TO BE IONIZED. THE RAMSCOOP IS PROBABLY EITHER ELECTROSTATIC OR SOME COMBINATION OF ELECTROSTATIC AND MAGNETIC FIELDS. IT WON'T INTERACT WITH NEUTRALS, AND AT THAT SPEED, IT PROBABLY CAN'T PROJECT ANYTHING AHEAD OF ITSELF TO IONIZE NEUTRALS. BUT I'M COMING HOME WITH A NEARLY FULL LOAD OF DEUTERIUM.

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Rockhound: I've got about half a load.

Iceman: Rendezvous has about 6,000 tons stockpiled, waiting for the next tanker to pick it up. No way to change locations, though. I'm transmitting this whole exchange to Earth, but there isn't time to wait for a reply. Maybe they can mount some kind of last-ditch defense with it. I hope they figure out the same thing, or something better, because that would give them another three days to prepare.

Searcher: Violet, if this thing gets past us, everybody in the inner system will probably die. You may be the only woman left. Don't do anything rash, okay?

Violet: You guys know I love to flirt and I love all the attention, but maybe, because I'm the only woman within 300 AU of here and you haven't seen another one in a while, you forget I'm over 80 years old. For me to be another Eve would take a team of medical specialists that are all going to cook if Sol blows up.

Rockhound: Anybody have any idea why we can't take this thing out just by dumping a rock with a mass of a ton or so in its path? At that speed, I would think it would effectively turn whatever it hit into energy. I've always heard that hitting even little stuff at relativistic speeds would be fatal.

Iceman: Yeah, Rock, it would cause a helluva bang, if you could hit something as small as the hull, which would be pretty difficult considering it will look like it's a light-year away just seconds before it hits you. Bussard would have been a lot better at this math than me, but I think there's something in General Relativity that acknowledges that the ramjet has been gorging on energy for decades while we've been sitting on our asses, and that probably biases the impact results heavily in its favor. I know there's an asymmetry like that for time dilation. And this won't be some passenger ship built like a big can. It will probably be more like a battering ram, times gamma cubed. If I were designing it, I'd give it one of those multi-layered meteor shields, probably made of thick armor plate, generously spaced apart by a framework. You might vaporize the first one and damage the second, but the bulk of the thing would survive.

Rockhound: Yeah, but it's still made of matter, right? Wouldn't a 2,000-megaton blast around the hull vaporize it?

Searcher: Negative, Rock. The Orion program, the one where they were going to try using nukes as rocket fuel, referenced some data from a couple of Bikini Island tests. They put big steel spheres very near the center of the blast, and they were barely scorched.

Iceman: Yeah, Orion! I should have remembered! Guys, I may have been pessimistic too soon. The equation I gave you a few minutes ago is for force required *in the direction of travel*. But at right angles, it's just $F = \gamma \cdot m \cdot a$. That's half a million times better! And Searcher, look up a test where they had a heavy plug on top of a low-yield nuke in one of the first underground tests, and kicked it to something like six times Earth's escape velocity. That should be in the Orion stuff. It inspired the project.

Searcher: Ice, you're right. That must be the Plumbbob program, a shot called Pascal B. If I'm reading this right, the yield was only about 300 ton—just a pop! You think we have a chance to push this thing aside? Can we make it turn if it can't turn itself?

Iceman: Hard to say. Probably at least part of that steering problem is the same reason we're getting so little warning: it's "chasing light" and is having trouble seeing ahead in time. If we could give it just 8,726 kph to one side, it would just miss the Sun. If we set off a 2,000-megaton explosion in contact with one side of a big chunk of armor plate with the mass of a battleship, I'd say it would work, probably by a big margin. But against 707 battleships? And we're just guessing at the mass of that thing. But with Searcher's trick, the scoop itself will direct the deuterium right in around the hull and set it off where it counts. And since it's almost a sure bet we'll hit it off-center, the force

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WILL BE OFF TO ONE SIDE. IT WILL BE DIFFICULT ENOUGH JUST TO FIGURE OUT THE TRAJECTORY, SO I'M NOT WORRIED WE'LL HIT IT DEAD CENTER.

I THINK TEDDY ROOSEVELT SAID, "DO WHAT YOU CAN, WITH WHAT YOU HAVE, WHERE YOU ARE." I THINK THAT'S WHAT WE HAVE.

SEARCHER: ICE, DO YOU READ HEINLEIN? "ALWAYS LISTEN TO EXPERTS. THEY'LL TELL YOU WHAT CAN'T BE DONE AND WHY. THEN DO IT."

YOU'RE RIGHT, IT WILL BE HARD TO HIT. BUT WE CAN ASSUME IT IS AIMED NEARLY DEAD CENTER OF THE SUN, PROBABLY WITHIN ONE FIFTIETH OF THE SUN'S RADIUS, AND WE KNOW IT CAN'T TURN ITSELF. EVEN IF IT HITS THE SUN BUT DOESN'T GET THAT CLOSE TO THE CORE, MAYBE THAT'S GOOD ENOUGH. AS I SEE IT, OUR BEST BET IS TO GET ON A STRAIGHT LINE BETWEEN WHERE WE SEE THAT THING NOW AND DEAD CENTER OF SOL. MOST OF US ARE PRETTY CLOSE RIGHT NOW. STINK AND CRUSTY, MAYBE YOU SHOULD START IN.

"Computer, cabin video log on." Victor waited for the record indicator to light up and turned toward the camera. "This is definitely worth recording for posterity. In my library is an old classic TV series, in which one of the characters says, 'do not confuse coincidence with fate.' A little while ago, the borebot cut this core sample and sent it up here." He tilted up a circular disc larger than a dinner plate, with a globular surface that was missing a small patch. "Watch this."

Victor picked up the flake of asteroid he had found a decade earlier in the inner system. Gently, he matched it up with a divot missing from the disc. The fractured surfaces matched up perfectly.

Victor smiled up at the camera. "Up to now, I've been able to think that good detective work is what led me here. Good luck played a role. It did take a little luck to find this flake, but even that was mostly orbital mechanics and a systematic radar search. After all my homework, there was about a one in a hundred chance that this object would be El Dorado, but that's not enough of a coincidence to impress a poker player. But to bore right down to this huge ball of iron, expose a three-meter diameter patch of it, and find the exact spot where the flake originated? Man, that's not coincidence, that's *destiny!*"

He glanced at his watch. "Damn, I haven't been on the net in over a day. They probably think I'm dead! I've got enough for a solid claim, and the forms are ready to file. I wonder if it's time to let the cat out of the bag?"

SEARCHER: ALL NET ALERT! EARTH JUST SENT THEIR BEST TRAJECTORY ESTIMATE. THEY'LL SEND REFINEMENTS AS FAST AS THEY COME IN. LOOKS LIKE WE'RE ALMOST ON THE LINE, JUST AS WE THOUGHT.

THEY FIGURED OUT EVERYTHING WE DID, AND MORE. THEY'VE GOT EVERY SHIP THAT CAN REACH THE TRAJECTORY MOVING OUT FOR AN INTERCEPT. THEY'RE ALSO GOING TO TRY DEUTERIUM RELEASE, BUT THEY'RE AFRAID IT WON'T WORK. THEIR ANALYSTS THINK THE RAMSCOOP WILL BE TURNED OFF SOME TIME BEFORE IT HITS THE SUN, TO BE SURE IT DOESN'T WASTE KINETIC ENERGY INTERACTING UNNECESSARILY WITH THE CORONA AND PHOTOSPHERE. MOST OF THE SHIPS ABLE TO MAKE AN INTERCEPT ARE WITHIN ABOUT FOUR AU OF THE SUN. THAT'S ABOUT HALF A LIGHT-HOUR. IN RAMJET TIME, THAT WOULD BE MORE LIKE TWO AND A HALF SECONDS, SO THERE IS A GOOD CHANCE IT WILL BE SWITCHED OFF BY THEN. AND IF WE CAN FIGURE OUT THE DEUTERIUM TRICK ON SHORT NOTICE, THE DESIGNERS COULD TOO, AND THEY WOULD SWITCH THE THING OFF BEFORE THEY THOUGHT THERE WAS A SERIOUS THREAT. THE BET IS THAT IT WON'T WORK.

SO THEIR MAIN STRATEGY IS TO GET EVERY SOLID OBJECT THEY CAN INTO THE PATH OF THAT THING, GIVE OR TAKE THE PROJECTED UNCERTAINTY. THEY'RE GOING TO MAKE IT RUN THE GAUNTLET, AND MAXIMIZE THE CHANCES FOR A DIRECT HIT. BUT THE TRAJECTORY IS WAY ABOVE THE ECLIPTIC. IT ISN'T COMING IN THROUGH THE KUIPER BELT AND ASTEROID BELT, AND THERE ARE NOT MANY HEAVY OBJECTS THEY COULD EVEN HOPE TO MOVE INTO ITS PATH, AND ONLY THREE BIG MASS DRIVERS ANYWHERE CLOSE. BASICALLY, THEY DON'T STAND A SNOW-

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BALL'S CHANCE IN HELL OF GETTING A 200-KILOMETER ASTEROID INTO THE PATH OF THAT THING.

SO THEY ARE DOING IT WITH SHIPS. THEY'VE GOT HUNDREDS OF THEM CONVERGING ON THE TRAJECTORY. THEY ARE EVEN INSTRUCTING THE SHIPS TO TURN BROADSIDE TO IT. THE ODDS OF A DIRECT HIT ARE STILL NOT GOOD. THE TROUBLE IS, ALL THIS IS TOO CLOSE IN. IF THEY MANAGED TO GET A SMALL ASTEROID IN ITS PATH, IT MIGHT MEAN THEY TURN A RIFLE SHOT AT POINT BLANK RANGE INTO A SHOTGUN BLAST AT POINT BLANK RANGE. SAME OUTCOME. BUT THAT THING WILL PROBABLY GO THROUGH A FREIGHTER LIKE A BULLET THROUGH TISSUE PAPER.

FRIENDS, THERE IS NOTHING BETWEEN US AND THEM. WE MAY BE FAR ENOUGH OUT TO KILL IT IN TIME. THERE'S A MUCH BETTER CHANCE THE RAMSCOOP WILL STILL BE TURNED ON OUT HERE, AS THEY GO FOR A LAST BURST OF ENERGY IN THE SLIGHTLY DENSER GAS AS THEY COME OUT OF INTERSTELLAR SPACE. THEY PROBABLY DON'T EXPECT WE WOULD HAVE ANYONE IN POSITION THIS FAR OUT. IT'S THE MOST FANTASTIC SHEER DUMB LUCK WE *ARE* HERE. AND IF WE CAN MANAGE TO BLAST THAT THING SIDEWAYS, MAYBE THEY'LL HAVE A CHANCE.

Victor reviewed the backlog of forum messages in shock. He finally regained his senses enough to begin processing the bad news. In the time he had been ignoring them, the news had gone from discovery of an almost comical rant from too far away to matter, to a serious doomsday threat. He glanced at the ship status display.

"I wonder if those jackasses are trying to punk me? Aretoo, get your sorry mechanical behind in gear and go dust the snow off the telescope dome."

"Command not valid," the robot panel complained.

"Aretoo, remove foreign material from telescope dome."

"Command accepted," the panel declared, and the display showed a maintenance robot scurrying down the trunk rail toward the telescopes.

Victor opened a data file attached to one of Searcher's posts, and transmitted the spherical coordinates to the gamma ray telescope. The coordinates would be easily in view at this point in El Dorado's rotation. A minute later, the robot reported the task was completed. Victor opened the dome and activated the telescope. The image quickly began integrating, and resolved a steady, bright pinpoint of hard gammas just where the incoming object should be. There was enough signal for a decent spectrum.

"I thought they said this thing was barely detectable. This scope is not *that* much better than the others. If those top peaks are supposed to be positron annihilation gammas, what's the blueshift? Um, works out to about 0.02, which would be 0.9992c. Could they be faking this? I don't see how. Jeez, they must be right, that thing is *screaming* in, way faster than it looked just a few hours ago.

"Computer, connect the spectra from the IR, visible, and UV scopes with the x-ray/gamma spectrum, and correct for blueshift of 0.02." Victor studied the display. "Interesting. That doesn't look like it's all heat. Computer, model and remove blackbody spectrum. Uh-huh, and there's a cutoff at the upper end. Reminds me of the electron-cyclotron resonance spectrum in a magnetic grid corner cusp, actually. This is *way* too sophisticated for those guys to fake. But what kind of field would cause ECR at a nanometer? Damn, it would take around ten million teslas. That's only an order of magnitude short of the polar field of a neutron star! So, you monster, you do use a magnetic field for at least part of your ramscoop operation.

"What the hell would something like that be *made* of, anyway? A nickel-iron structure would be crushed by a field that strong. In fact, it's more than a million times stronger than a field that would levitate diamagnetic materials, so it would probably tear carbon fiber to shreds.

"How fast would something like this expand? It would only be seven hours

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behind the light it emitted a light-year out! And if it's doing six nines of light . . . that drops to half a minute! It will blossom from a pinpoint to as big as the moon in a heartbeat, as if it were coming in faster than light!

"So next, I suppose I'm expected to push off from here and go out and take up position to try and stop that damned thing. Screw that shit! Nobody has said it, exactly, but I'd say it is a safe bet what they're talking about would be fatal. The odds are I won't be close enough anyway. Nobody else out here has as much to lose as I do. Let one of those other poor bastards do it, since they're all so eager to die."

Another updated trajectory came in. The estimated error cone was tighter now, definitely centered west of the station. El Dorado was near the center.

"Shit, what are the odds that thing is gonna hit my pot of gold?" He ran the calculation. "Slim. Close to zero, in fact. It'll probably pass about a hundred thousand klicks east of here. Odds are better I can use it to shield me when that thing goes by. Damn, that's a lot of gamma rays! And Ice was right: Even if I wanted to push this thing into the most probable path, no way do I have enough impulse, not by a factor of a thousand at least, so they can't blame me for not trying."

Victor paused to think. "They can't blame me for not trying to push El Dorado. They'd blame me for not getting out there to try to stop this thing. My tanks are chock full of high-grade fusion fuel, and the best projection is just a few hours east of me. So if I just let this thing go by and do nothing, and Earth gets cooked, and then I come in and file a claim on El Dorado, they'll know I was right there and just watched it go by. Man, if I think I'm short on friends now, imagine afterwards."

A motor down in the bowels of the ship growled as the borebot was raised back into its bay.

"Says you!" Victor glowered at nothing in particular. "You forget, my tin friend, that if we try to stop that thing, you fry with me. So let's not even go there. The fact is, I'll be so rich, those toads will be kissing my ass anyway."

Victor froze. "Or . . . wait. Shit, my whole damned business model is screwed to hell! If the inner system is destroyed, what do I do for a customer base?" He paused to think again.

A nasty smile formed on his face. "But I'd still be sitting on top of the richest find the Oort Cloud has ever produced. There are what, four exploration outposts out here, plus that deep exploration ship, *Nemesis,* out about a quarter light-year on the ecliptic? The inverse square law is the best shielding, so they say. The other outposts will probably get thru this without a scratch, and that ship certainly will. So humanity will survive. We'll just start over out here. It will take a few generations before it means much, but I'll still be the richest man in the system. And if I have a chance of stopping that thing, it looks like at least three other ships have about the same chance. Maybe Earth won't be destroyed after all. I'll pay for a really nice statue in honor of whoever intercepts it."

"Aaargh! There aren't many medical doctors out here! I wonder how long it would take us to re-create the life extension technology they have in-system?"

The last forum exchange with Violet crossed his mind. "Hell, there's another hole in my plan. I don't even know if there are any women of childbearing age out in the Cloud at all: Because of the radiation hazards, most women with the itch to come out and explore wait until those days are behind them."

A valve deep in the ship hissed loudly, venting gas in preparation for decoupling the borebot's umbilical.

"Yeah?" Victor replied, "So what if I am a piece of shit? Now shut up and get back to work."

SEARCHER: I GUESS YOU GUYS ARE WATCHING THESE TRAJECTORY UPDATES. THEY ARE RAPIDLY

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CONVERGING WEST OF RENDEZVOUS. ALL OF THIS INFORMATION FROM EARTH IS OLD NEWS. WE'LL PROBABLY BE TOO FAR BEHIND IF WE DEPEND ON THEM MUCH LONGER. AT THIS POINT, I'D SAY WE HAVE TO TREAT THIS LIKE ANY OTHER VISUAL INTERCEPTION, JUST WITH REALLY BIZARRE VELOCITIES. THAT THING IS GOING TO SUDDENLY START LOOMING LARGE, PROBABLY IN A FEW HOURS, AND WHEN IT HAPPENS, IT WILL BARELY BE POSSIBLE TO REACT. WHEN YOUR TARGET IS NOT MOVING RELATIVE TO YOUR FIELD OF VIEW, ONLY BLOSSOMING IN YOUR VIEW SCREEN, YOU'RE ON AN INTERCEPT COURSE. TRY TO STAY CENTERED ON IT THE BEST YOU CAN. PETE, CRUSTY, IT LOOKS LIKE YOU GUYS ARE OFF THE HOOK. YOU CAN'T POSSIBLY GET HERE IN TIME. ICE, DOESN'T LOOK LIKE RENDEZVOUS WILL BE IN PLAY, EITHER. HAS ANYBODY HEARD FROM WIENER? THAT THING WILL PROBABLY PASS WEST OF THAT LITTLE ICE BALL HE'S EXPLORING, AND HE PROBABLY COULD GET THERE IN TIME. HE SHOULD HAVE FULL TANKS BY NOW.

Victor stared at the core sample disk. Hatred burned in his eyes. The latest trajectory update was still on his screen, with the estimate of the launch date, the same year Victor had been born.

"It's not fair. You stupid chunk of inanimate matter, you suckered me out here, didn't you? Both of you. You and my flaky little buddy sitting in that divot. Man, I should have lashed myself to a mast and not let you two sirens seduce me. But that wouldn't have helped, would it? I'd probably be back in the belt and I'd fry with everyone else. So it's my fault. I should have picked Rendezvous 2 instead of Rendezvous 3. But then I'd never find El Dorado, and I'd just be a poor, lonely ice miner, living out my years out in the dark and cold and wishing there were some women around."

Victor continued to stare at the disk, as the wheels ground furiously in his mind.

"How the hell did you get out here, you stupid ball of iron? Did God do it? Could some all-powerful, all-knowing son of a bitch have foreseen all this? I mean, this all started over four billion years ago. Life on Earth—and the other world too, I suppose—couldn't have been more than slime in mud puddles, if it even existed then! How could anyone, even an omniscient being, know this would happen, now, here? Even if God is a magnificent billiards player, how could He possibly predict the future, when creatures with free will are involved?"

He placed his head in his hands, sobbing. "What's the matter with your aim, God? Did you miss? Is that it? Yeah, admit it. You were off a tiny hundred thousand kilometers after the billiards shot of all time! So you lure me out here to fix the problem, is that it?"

He inhaled sharply, as if startled, and then sighed. "No, that was never the plan, was it? You put El Dorado here for us, but it was up to us to take the final step. That's it, isn't it? You lousy son of a bitch!"

Victor thought some more, then picked up the core sample disk and placed it in a sample transporter. "Computer, jettison this. Maybe somebody will find it and make a memorial out of it."

"Command one accepted," the 'bot panel replied. "Command two not understood."

"Computer, disregard command two. Prepare for departure. Disregard my metaphysical ramblings. The problem is not that I can't tell the difference between coincidence and fate, the problem is that I can't tell the difference between *destiny* and fate."

WIENER: VICTOR GENDEG CHECKING IN. SORRY GUYS, I'VE BEEN SANDBAGGING. I'M IN PRIME POSITION, WELL TO THE WEST OF WHERE YOU EXPECTED ME. I HAVE A FULL LOAD OF ABOUT 90 PERCENT DEUTERIUM, 10 PERCENT HELIUM-3. I AM TRANSMITTING MY STATE VECTOR AND MY LOGS. IN MY LOGS, YOU WILL FIND THE STATE VECTOR, ASSAY, AND CLAIM APPLICATION FOR THE BODY I WAS REALLY EXPLORING. IT WILL PROBABLY SURVIVE WHATEVER IS COM-

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ING, AND YOU'LL WANT TO GET OVER HERE AND CHECK IT OUT. PLEASE GIVE IT TO EVERYONE I FAILED TO APPRECIATE WHEN IT WOULD HAVE MATTERED. I THINK THAT WOULD INCLUDE THE WHOLE HUMAN RACE. ANYWAY, REVIEW THE LOGS, AND YOU'LL KNOW THAT I'M NO DAMNED HERO. FATE JUST PICKED ME FOR THIS.

"Computer, commence live broadcast of voice and data."

Victor scanned the operations manual on computer display. "To whoever is listening, I'm trying to dump my deuterium tanks, but they got cold a few seconds after I opened the valves, and now nothing is coming out. The tank heaters aren't adequate for this much flow. Shit, every space ship in the movies has a self-destruct. How come there's no way to blow this sucker up? The damned engineers made it foolproof. If only I had a nuke! All I have are some little mining charges."

He looked at the telescope display. Every minute, the glowing disk with the fiery speck in the center grew larger. "Hell of a lot of hard gammas. I wonder if Violet was wrong? Maybe the gammas will ionize the gas, if I can get it expelled in time." He closed the vent valves, brought up a stern view of the ship, and touched points on the aft ends of the storage tanks. "Aretoo, plant a five kilogram mining charge on each of the following points. Emergency safety protocol override."

"This instruction violates your lease and insurance provisions," the computer warned.

"I accept the liability, and my deductible is on deposit," Victor growled at the machine. "I'm the freaking money-grubbing MBA around here. You are just a rental. I don't really give a shit what you think. I'm not in a particularly good mood right now."

"Emergency safety protocol override accepted. Unintelligible commands ignored." The robot panel display showed the maintenance robot racing to its final mission.

He looked back at the telescope display. "Looks like we're still about dead center. I think Ice is probably right . . . it makes more sense to try to concentrate the blast a little off to one side. If we stick with the assumption the thing will aim for dead center of the Sun, the error cone is pretty small this close in. Computer, display Earth's location relative to the Sun, with celestial axes. Show object's trajectory." He nodded. "Computer, show target with celestial axes." He held up one hand with fingers projected to visualize the relative orientations. "Now, time for a wild guess. Computer, adjust interception point to ten kilometers southeast of the trajectory error cone center."

Victor shook his head as he felt the thrusters kick in. "I'm fooling myself thinking that thing is that accurate. If only there were more time! Dammit, I don't know how long it would take for the gammas to ionize this much gas at this density. This is basically going to be a liquid hydrogen dump. It will probably be a fog of droplets for a while. Hell, I don't even know the density. Just gotta dump it and hope.

"Damn, how fast would the field fall off with distance? I figured ten million teslas near the center, but a magnetic field will fall off as the cube of distance. Near the center, it ought to be a steep funnel, and the energy stored in the field itself will be incredible. A few hundred kilometers out, it will be too weak to handle a big mass of ions. The electric field won't fall off as fast, but the Debye lengths in a dense cloud will mean most of the ions won't even see the field. The release has to be almost right down its throat. If anybody is listening, you need to get as close as you can."

A few minutes later, the maintenance robot indicated the task was complete, there was a trace of pressure in the tanks again, and the ship was braking to the new position. Victor swung Iceman's leased ship around and pointed the stern at the rapidly approaching disk

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of hellish radiation, then typed a command on his console. The ship shuddered and lurched forward. He checked the display. A dense mass of frigid liquid and gas boiled behind the ship, the globs subdividing more with each second, obscuring his view of the approaching ramjet.

"I gotta get some heat into that stuff to vaporize it, and ionize what I can. Maybe the ionization doesn't need to be complete. The density is certainly high enough for a few minutes that collisions will make a cascade ionization, especially when it gets slammed by that scoop and sucked in. Computer, reactors to full emergency power. Set reaction mass flow to maximize output of ions at one hundred electron volts. We're going to light that cloud up."

"Command accepted. Reactors at twenty gigawatts. Full thrust in two seconds, one, fire. Unintelligible command ignored." An alarm sounded a second later. "External gamma radiation is exceeding shielding limits. Cabin radiation dangerously high."

Victor strained against the acceleration as the ship blasted away from the cloud of boiling fusion fuel. "All I can say is that this damned well better work. How far ahead would that thing be able to detect this release? A fraction of a second in ship-time, I'll bet. Could it switch off the ramscoop in time? What am I babbling about? Of *course* this is going to work. Why else would I be here? I can't possibly miss. God, if you're listening, if you let me into Heaven, there better be a thousand virgins waiting for me. And if you send me to Hell, Satan's going to wish he never got whoever launched this thing to worship him. 'Tis a far, far better thing I do. . . ."

The recording ended. "That's when we lost his transmission in the radio noise." Iceman pressed a button on the bar's holographic projector. "Here's what happened a few seconds later. How long did we calculate the ramscoop would be? Yet relativity has foreshortened it to almost a flat disk. Looks kinda like a cosmic flyswatter, doesn't it? It was probably quick. Most of his pain he had already gotten through.

"Keep watching. You can see I had to switch telescopes in quick succession, since the emissions changed to redshift as it passed. As near as I can tell, he missed the hull by all of about two kilometers. Absolutely a miraculous job of targeting. You can see that the core flared up, but it isn't really obvious that anything useful happened. I'll speed it up. Now, you see the ramscoop field is disintegrating and the core is starting to break up. Looks like there are about three main pieces, six smaller ones, and a cloud of little stuff. The yield was a lot higher than we thought, probably because the big magnets he detected were storing a few gigatons of energy themselves, and they ruptured on the same side as the deuterium blast. The trajectory changed just about a thousandth of a degree, just enough that those big pieces will clear Sol."

Frosty swirled his glass and sniffed Ice's best cognac. "Any idea how the inner system is going to fare? They've still got one hell of a lot of debris heading their way at nearly the speed of light. I imagine a pea-sized piece would hit like a nuke."

Ice nodded. "That's for sure. But very little of it will hit the Sun, and he managed to scatter most of it away from Earth. They could still catch hell, no doubt, but most of them will live. We'll start finding out in less than a week."

Crusty ran his fingers through his long, white hair, then stood up from his barstool to speak. "Now that you good folk have seen and heard his logs, I'd like a little agreement. I say we edit out everything but a few choice quotes, and just release the good stuff to the press. Those recordings just have too much private information. Pretty obvious that the guy was reluctant. Well, I don't mind telling you I felt some guilty relief when

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Searcher told me I was too far out to take a shot at that thing. Being fearless is just stupid. Don't confuse that with being brave. And nobody says you have to *like* a choice like that. I'll bet the reason Pete is still out there is he feels guilty he couldn't help."

Rock shook his head. "Man, I'd hate to have had a camera on me. I would have been too ashamed of how I felt to ever admit to a recording if I made one. I guess Victor felt so ashamed of how he felt, he had to tell us. I think that says something about his character.

"I threw the switch to dump my tanks, cursing my bad luck and shaking like a leaf, and had the same problem Victor did. As soon as the liquid deuterium started boiling, the temperature dropped and the pressure went away. The tanks are just not designed for a fast dump. I got preoccupied trying to figure out a solution, when I realized too late I wasn't on the path. And then I just started crying like a baby, half because I had failed, half because I was relieved. What they say about the stink of fear, I tell you, that's *real!* I had to toss that jumpsuit."

"You guys were all hauling deuterium." Searcher swirled his snifter glumly. "All I had was inert reaction mass for the electric propulsion system. I could have gotten in position, but it probably wouldn't have done any good. But all those guys in the inner system were doing it. Why didn't I? I sure was willing enough to talk all of you into doing it."

"I'll tell you why I didn't," Violet confessed. "I told myself it was because I couldn't reach the intercept point in time, but the truth is, I could have. I couldn't have stopped there, and my targeting wouldn't have been precise, but I could have tried to release my payload in time. But I hesitated too long because, in the back of my head, I knew I had the excuse that I might be the only woman left if we failed. Me and my shriveled-up eggs. I'm a great-grandmother, with another generation on the way. I've got two kids, five grandkids about Victor's age, and they've got nine kids between them. I should have been thinking about protecting them."

"You would have had the same problem . . . you couldn't have dumped your payload fast enough," Rock pointed out.

"I should have died trying," Violet declared, staring at her glass.

Frosty shook his head. "You guys don't get it, do you? Search, let's say you managed to get right in front of that ship and it ripped through you? What would you accomplish?"

Searcher started to open his mouth, and Frosty held up his hand. "Shut up and hear the truth. You would probably have knocked off some little dingus that was a critical part of the ramscoop generating equipment, and it never would have picked up Victor's load of deuterium. It would still have hit the Sun, but nobody would be able to see it coming any more, so all later attempts at defense would fail. And Violet, you probably would have given it a burp of gas, just enough to trigger it to shut down. Same result."

Rock protested, "But I had a decent chance . . . ."

"Shush, fool," Frosty snarled. "You were on the wrong side of it, with only half a load of deuterium, not a clue how to deploy it, and I'll bet with a half-assed repair to your telescope. You would probably have been so far off-center the slug of dense gas would have locally overloaded the ramscoop and not been collected. No telling what kind of trouble you would have caused. No, sir, none of you were *supposed* to stop that thing. It wasn't in the plan."

Violet raised an eyebrow. "Damn, Frosty, did you just get religion?"

Frosty sighed. "Good question. Ever since Searcher proposed that deuterium release, I've been looking at the whole problem of taking in that much gas at once. It just doesn't make any sense. Yeah, Victor shoved it right down its throat, right where the ramscoop field

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would be strongest. But it was a hundred tons in maybe a microsecond, not a kilogram in a second like it was designed for. I don't understand why it didn't just blast right thru the field. I've looked at what the field intensity should have been, how much energy it would store, relativistic effects, and it just don't add up. It's like the ramscoop was made of diamond fiber or something. Like maybe there was something else holding it together.

"One thing is for sure, right there at the end, Victor sure did seem convinced that what he was doing was bound to work. How many of the rest of you could say you would have gone out with a feeling like that?"

Frosty surveyed the room. "Thought so. Me neither. We're all sitting here kicking ourselves because we thought we might have had a chance, but we failed. Just think of all those poor heroes pissing themselves in the inner system, knowing they were doing too little, too late. Imagine being *sure* you were going to fail. Victor was blessed, my friends. *Blessed.*"

Ice raised his glass. "I can't tell you how many years I hoped to stumble on that damned asteroid core. And don't any of you deny it . . . you did too. He actually had his hands on the prize. Fate stuck a knife in him and gave it a sharp twist. So what if he bitched and fumed all the way? He didn't have to be dragged kicking and screaming. He did what needed to be done, on his own. He did it brilliantly, in fact, no pun intended. All anyone else really needs to know is that he gave up more than most people ever dream of for the good of the entire human race. Regardless of whether he would approve or not, I raise a toast to a true hero." ■

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You could compile the worst book in the world entirely out of selected passages from the best writers in the world.

—G. K. Chesterton

It is good to have an end to journey toward, but it is the journey that matters in the end.

—Ursula K. LeGuin

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The line between "who" and "what" is likely to get less and less distinct. . . .

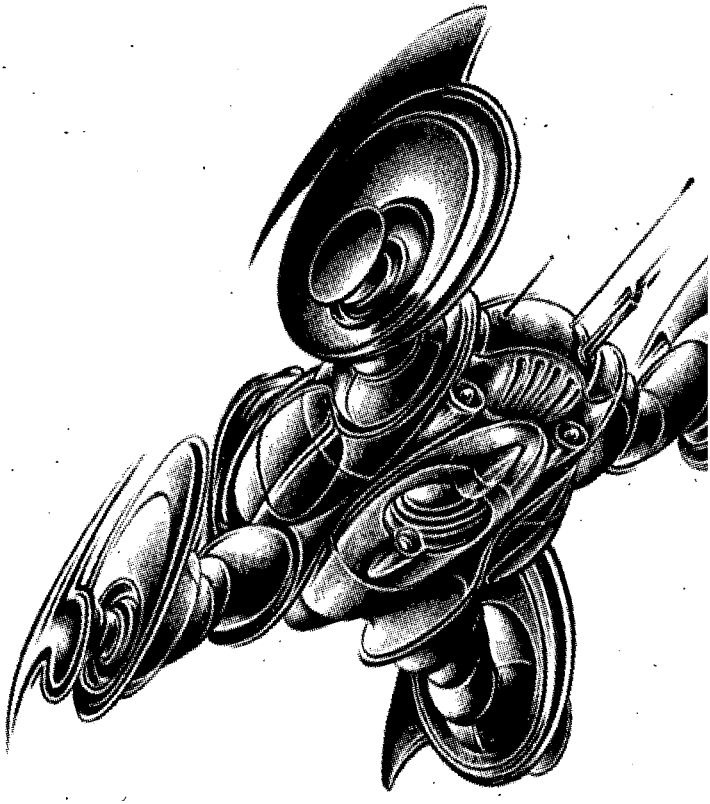

Illustration by John Allemand

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The Hangingstone Rat

Barry B. Longyear

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Early on a late summer morning Artificial Beings Crimes took a call from Okehampton Station reporting a dead bio in North Dartmoor at a place called Hangingstone Hill. The location was seven kilometers south-southeast of the army camp, deceased was a dead male rodent amdroid reported by a hiker: no apparent signs of violence, scene marked, hiker's statement received, constable standing by. Rodent bios aren't terribly long lived, and it was likely the fellow simply happened to be on the moor when he pegged it. Likely the death was natural and the owner of the engrams had another meat suit in stasis. Nonetheless, it had to be investigated, and it was a welcome opportunity to get out of the city. At home in Exeter, as I waited for Shad to pick me up with the cruiser, I used Val's computer and looked up Hangingstone Hill: a minor legend, unremarkable history, third highest elevation on the moor.

"Guy's here," Val called from the hallway. She padded into the lounge and hopped up on the desk. I gave her ears a perfunctory scratch. My wife was a Golden Tonkinese.

"Have a good day, dear," I said as I went to get my coat.

She looked at the computer screen. "You have a call out on the moor?"

I pulled on my coat and sealed it. "Yes. Shouldn't be much of anything, dear. Dead rat bio reported by a hiker."

"Well, take care, Harry. I have a premonition."

I smiled. "Remember your last premonition, dear? Wasn't it a furball?"

"Even so, Harry, take care. I don't like rats."

"I understand rats feel the same way about cats. Good-bye, dear."

"We're coming up on the moor," Shad quacked. He was a mallard duck bio and flew the cruiser remotely by means of his wireless interface. He had once been a quite famous telly star doing adverts for an insurance firm "in whiteface," as he put it. We talked old movies for a while then fell silent as we watched the rugged greenness of Dartmoor spread before us.

"Pick up the Vader prang beacon yet?" I asked him.

"We're right on the wire."

I looked over the vast expanses of hilly heather, broken only by granite-topped hills, boulder fields, ponds, peat bogs, and stream-carved cleaves. Among them the shadows of clouds seemed fixed in place. I could see for miles. What I failed to see was the constabulary cruiser that was supposed to be waiting for us. "I don't see the cop supposed to meet us, Shad."

He glanced at me. "You're the one who pointed out to me the low esteem in which ABCD is held among the constabulary."

"This juvenile anchor dragging grows tedious, nevertheless."

"Hangingstone Hill up ahead," announced Shad. "Ought to be a movie title," he concluded whimsically.

I smiled. *"Hangingstone Hill,* a western tale of murder and vengeance, torn from the pages of history, directed by John Ford—"

"—Starring Susan Hayward and Gary Cooper," completed Shad.

"I always loved Susan Hayward. Wasn't there a Gary Cooper film called *The Hanging Tree?"* I asked.

"Nineteen fifty-six," said Shad, flaunting his vast cinematic knowledge. The theater was never far from the former insurance duck's thoughts. "Gary Cooper and Maria Schell," he continued. "You know, *The Hanging Tree* was George C. Scott's movie debut."

"Really. Well, Shad, I know why Hangingstone Hill carries such an ominous name."

"Oh?" He was silent for a beat. "You do?"

It does me good to stump the duck once in awhile. "It has to do with a natural phenomenon, Shad: a rather big plate of rock called a logan stone that hangs out over another rock on the side

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of the hill."

"That's disappointing," Shad remarked. "With a name like Hangingstone Hill the place ought to be covered in ghosts left over from innumerable medieval neck stretchings. *Turnkeys With Gibbets,"* imagined Shad aloud. "A Cranberry and Gravy Production. You can be the sheriff. Everyone expects British sheriffs to look like Basil Rathbone."

"Sorry?" I said. "Cranberries?"

"A Thanksgiving reference. U.S. holiday? Turkey and giblets? Forget it."

I glanced at Shad. "Legend has it that a seventeenth-century mayor of Okehampton was hanged on Hangingstone Hill."

"They must've brought their own gibbet with them," said Shad as he changed heading a few degrees south. "Look at the hills around here. Not a tree in sight. Okay," he relented, "why'd they hang him?"

"Stealing sheep."

"They gave him the rope on a mutton rap? Tough town."

"I'm certain the mayor represented the charges against him as being politically motivated."

"So that's where that came from."

"Indeed, but it wasn't only the mayor's body that was sentenced. His spirit was sentenced to empty with a sieve Cranmere Pool—that's at the west foot of Hangingstone."

"Now that's hard time."

"Not at all," I said. "The clever fellow lined his sieve with sheepskin and proceeded to empty the thing. Cranmere Pool has no water in it."

"So he beat the rap?"

"Not quite. The punishment was altered to having to weave the sand at the bottom of the pool into a rope. Poor fellow's still at it, I imagine." I again looked for the constabulary electric. "Shad, I still do not see a car."

"Nothing on the instruments," he responded. "The scene analyzer beacon is located on the northwest side of the hill. What's that hut down there?"

Directly in front of us was a high hill with gentle slopes. On its north end were the remains of a stone shack, its shed roof partially collapsed. "That's an old artillery observation post. For centuries this end of the moor was an artillery range. Incidentally, ducks, the army still advises hikers not to pick up any curiosities they might find out here."

"Souvenir go boom; important safety tip."

"Very well, Shad, ring up Okehampton Station and find out where their missing constable is. Meanwhile, put us down near the prang."

While he did that I turned in my seat and ran up the mechs: vehicles of various sizes and configurations, big walking to micro flying, into which we could copy to get into difficult places allowing us to collect and analyze evidence. Shad put down the cruiser on the northwest slope of the hill about five meters above the aforementioned logan stone. The sunlight reflected from the polished metal Vader prang, cop slang for the pencil-thin scene analyzer mounted on the southwest edge of the rock plate. It would be facing the corpse. I looked in that direction but could see nothing among the heather. It was, at least, not a terribly large rat.

"Jaggs, guy on the phone says Okehampton cops can't find any Hangingstone Hill report. He says they didn't call in a dead bio to ABCD this morning."

"Rubbish."

"The call would have been automatically logged and recorded, according to their man PC Sudbury, and he can find no such record in the computer. Case closed."

"Tell him to pull his ruddy thumb out and try again."

The doors rotated up, and I held up a hand to Shad. "Before that, let's see if we even have a body. This is beginning to look suspiciously like a hoax."

"Local yokels having a little fun with ABCD?" suggested the duck.

"Perhaps the constabulary having a laugh." I climbed out of the cruiser,

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stood, and took a few steps down toward the stone. Southwest of it, perhaps two meters distant, I could see in the heather what looked like the body of a rat with a body comparable in size to that of a gray squirrel. It was lying on its left side. Shad flew up next to me. "Okay," he said as he landed, "at least we have a corpse."

"Yes. A bio. I can still read the receiver signal. Perhaps we can harvest the engrams before it zeroes out."

"I wonder why someone would copy into a rat bio?" said Shad. "Why would they *want* to? And what's a rat with a human engram imprint doing out here in the boonies—and with no cheese?"

"Perhaps he ate all his cheese and expired from despondency," I suggested facetiously. "I'll sort the calls, Shad. After you make a try on the engrams, get a scan, temp, DNA, and ID."

"You got it."

I rang up Okehampton Camp army base, and reception was scratchy. Either my phone was having problems or not all government departments communicate via satellite. As the operator there began passing my call around from pillar to post by slowest means available, I climbed uphill in hopes of better reception. As I stood facing the direction of the army camp, High Willhays and Yes tors visible in the distant haze, a Sergeant Vickers of the military police came on. A rather long-winded bloke, he was about to do my head in explaining, with maximum words per bit of information, he had no notice, knowledge, or note of anything concerning dead bodies of any kind, type, condition, description, or designation, today or at any other time, and, moreover, even should it be discovered in some manner at some time in the future that he had—

As I tensed, waiting for the fellow to take a breath for interruption purposes, the earth was pulled from beneath my feet and an enormous hand of sound, force, and heat rose and swatted me like a mosquito sending me flying up into absolute blackness.

Splitting headache. Overpowering silence, my body numb. My eyes opened to a confusing smear of images. A strong chemical odor stung my nostrils. Gradually the images resolved into fuzzy clouds, fuzzy hills, fuzzy sky, and shadows, everything through a stinking gray mist. Pain began invading my right ankle, my legs, then my whole body. I tried to call Shad, but I couldn't hear my own voice. I gently rolled to my right and saw blood appearing on my right hand and sleeve. Managed to push against the ground until I was sitting upright, weaving, everything threatening to go black again. I couldn't see the cruiser.

My hand rested upon the edge of a very warm rock. I looked at the stone and it was a largish plate that could have been the twin of the hanging stone, but bottom side up. Then I saw a fuzzy gleam of silver and realized it was the self same hanging stone, the scene analyzer apparently none the worse for wear and still attached to its edge. The rock had landed just a few centimeters from me.

I looked for my phone and it was missing, probably somewhere beneath the rock. Tried shouting for Shad again, but still couldn't hear myself. Struggled to my feet, standing there feeling lightheaded, a sharp pain in my right ankle. I looked down and saw to my dismay both shoes and socks missing, my right ankle swollen, and my right foot at a funny angle. My trouser cuffs were shredded. While I was staring at that, blood spatter appeared on my feet. It was coming from my nose. Further exploration revealed blood coming from my ears as well. Principal flow, though, came from a cut on the left side of my neck. I held my hand over it and stumbled down slope toward the stone's original location, calling for Shad, still unable to hear.

Nothing was left where the rat had been. Hanging stone, heather, grass, soil, rodent, cruiser, and Shad were gone. Steaming hot granite and that insidious

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chemical odor were all that remained. I couldn't think of what to do.

I turned around slowly. Farther upslope something was burning. I stumbled uphill far enough to see the cruiser's remains: twisted black metal pieces, flames still licking up from the few bits of remaining upholstery and combustible forensic supplies it had contained. The disembodied hand of the large walking mech was on the ground next to a few scorched feathers and charred bits of flesh. Thin piece of bone, something that looked like the tail of a rat. I couldn't make out either the rat's or Shad's bio receivers. Just then the universe went as black as Newgate's knocker and I fell, wondering as I did so if I was going to die again.

From later accounts I gather Sergeant Vickers grew concerned when, shortly after losing my signal, the sound of a great explosion came from the south. He had an air ambulance come immediately, and they managed to piece enough of me together to get me to camp hospital alive. When I first regained consciousness, however, it was night, and I was in Royal Devon & Exeter Hospital in the city. I knew I hadn't died because, unlike my original demise, I awakened in the same body replete with every broken bone and aching cell. Topping the pain inventory was a headache that could gobble steel ingots and blow off razor wire. Soon there was a fellow stabbing into my retinas with an intense light beam and asking my name, the year, and the name of the reigning monarch. When the spots cleared and I managed a look at the bleeder, he appeared as though he ought to be peddling used trusses: slicked black hair, widow's peak, pinched up dark eyes, a hand-painted tie, and a nose like a broken rudder. The nametag on his white coat was red, but I couldn't focus well enough to read it. The man's voice came through in tinny flat tones and only through my left ear. I pointed.

"Temporary hearing assistance patch attached to your left temple," he said. "Can you tell me your name?"

"I believe I can."

He waited for a moment, then raised his evil-looking little eyebrows. "What is it?"

"Jaggers. Detective Inspector Harrington Jaggers, Devon ABCD." I looked at my surroundings. The room was small, off-white and white, a screen to my right displaying my vital signs to anyone who might wander in. On the wall opposite my bed I could make out a framed photo of what appeared to be a Quay scene: Cricklepit Bridge from Waterside. Shad had loved it down at the Quay.

"I fancy they call you Harry, eh?"

I looked in the direction of the voice and apparently the truss monger had failed to remove himself. "My wife calls me Harry. However, sir, you may address me by my nickname."

"What's that?" he asked expectantly.

"Inspector."

His evilly peaked eyebrows arched, then lowered into grim mode. An unfriendly edge crept into his voice. "Can you tell me the year?"

"I don't wish to be more rude than necessary, fellow, but who *are* you?"

With the index finger of his right hand he tapped his nametag. "Dr. Truscott."

I had little time to consider the marketing possibilities in Truscott's Terrific Trusses, as he had more to say. From what he said I was made aware that I should consider myself a very lucky fellow. Aside from a few lacerations, a broken ankle, four broken ribs, a sewn together carotid artery, deafness, chronic headaches, slightly impaired vision, bruised organs, a dozen or more badly pulled muscles, a dead partner, a crime scene blown to bloody hell, and an unsolved case concerning a now missing corpse, I was going to be just fine.

He apparently decided to make another try at being conversational. "I worked on your model cop replacement bio back in medical school," he said reminiscently. "A piece of history. 'Bones' we

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used to call them—for Basil Rathbone? The twentieth century movie actor?"

"Never heard of him."

"Really? Well, your model bio is very durable, infection resistant, and you look like a late-night Sherlock Holmes, eh?"

Mentally I almost expected Shad to be at my side remarking, *"I say, Holmes, what medical school did this fellow attend?"* to which I would reply, *"Elementary, my dear Watson. Elementary."*

Truscott was still there and he continued: My right ankle was set, protected, and held in place with a balloon cast. The chip in the cast would monitor the swelling and adjust the cast accordingly. The ankle would heal. With assistance my hearing would be fully restored. Once my brain recovered from being thoroughly sloshed around in my brainpan, the headaches should subside and the fuzziness in my vision ought to clear. In addition, a grief therapist was waiting in the wings simply keen to deal with my roast duck problem, nudge nudge.

There are times when one hears something so coarse, vile, or outrageous one automatically assumes one has heard incorrectly. "Did you say 'roast duck'?"

The man smugged up, apparently quite pleased at his little joke. "We understand when they sent an ambulance for you they sent the chef from a Chinese restaurant for the duck."

"That duck was a bio and my partner."

"It *was* a duck suit, however."

"He was named Guy Shad, *he* was carrying a human imprint, *and* he was a detective sergeant in Artificial Beings Crimes."

"No offense, Inspector. Just a little joke. Lighten the mood a bit? Just an android suit, right? Not the end of the world, is it? Must've looked like that though when it happened, eh? Ah-hah-hah-hah."

If my head hadn't been aching so terribly, I would've throttled the wanker with his own stethoscope.

"One last item," he said. "Your hearing implant: Do you prefer normal or wireless?"

"What?" I was still mentally occupied, contemplating murder while I could still reasonably pull off a diminished capacity plea.

"Your bio isn't equipped with wireless, but I wanted to let you know the option is available. The current hearing implants for your model all come with the latest wireless interface. If you prefer we can attempt to locate a pair of the old implants—wirelessless, eh?" He preened at his lame wordplay, making me reconsider the prohibition against ABCD detectives in Britain carrying guns.

All the forensic mechs come with wireless, which is how I knew I preferred normal. I abhorred even the idea of someone unbidden ringing me inside my own head. Shad, whose bio came with the latest of everything technical, always teased me about refusing to change. *"In Artificial Beings Crimes,"* he once said, *"we have John Dillinger, a gorilla, a bloodhound, a duck, and a dinosaur."*

I was the dinosaur. I'm not certain why, but I chose the wireless implants. I could always disable the wireless function if my sanity was threatened.

A few marks on a chart, another deeply offensive attempt at apologizing for any of his possibly insensitive remarks concerning my "dead bird," then trusses-for-less mercifully departed. Truscott was replaced by my boss, Detective Superintendent Marvin Matheson. Entering the room with him was a young constabulary detective who said he was from Okehampton Station. He introduced himself as D. C. Frank Storel.

As my dead-cop-replacement meat suit model resembled Nineteen forties actor Basil Rathbone, Matheson's even earlier replacement bio looked like old-time American gangster John Dillinger, which was much appreciated by his wife. Much appreciated by Shad, too, principally as a target for his humor. Couldn't recall Shad's jokes just then. Not much of anything seemed funny except the new

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face.

Storel was a human natural who resembled a twenty-first-century Middle Eastern historical figure whose name I hadn't managed to retain. He was short, thin, puny looking, his mousy brown hair brushed forward, his face displaying uncertain intentions of growing a beard and moustache. He wore a butternut colored windbreaker over a buttoned up necktie-barren white shirt. Raised eyebrows and a permanent simpleton's grin on his face completed the picture. Instead of evidence of brain damage, his facial configuration was, one hoped, merely a stab at putting me at ease. Matheson sat in a chair next to my left side. Storel remained standing at the foot of my bed.

The superintendent leaned toward me. "D. C. Storel has a few questions."

"Indeed."

Storel looked down into his chip pad. After ID formalities were concluded, he asked, "Do you know where the bird was standing when the dud went off?"

"His name is Detective Sergeant Guy Shad," I said.

"Sorry, Inspector. No offense."

"Has that been determined?"

He looked up from his pad and grinned even more widely. "Sorry?"

"Indeed. Has it been determined that the explosion was an artillery shell? A dud?"

"Of course . . ." The grin faded and he looked confused. "Well, what else could it've been?"

"D. C. Storel, that explosion might have been an IED, a land mine, a booby trap, a bomb, a robotic missile, or movie set special effects for a British remake of *No. Time For Sergeants*. Perhaps we're getting too bleeding close to making that first contact with alien lifeforms and this was some half-arsed Nebulan bugger-eyed monster's way of warning us the hell off!"

"Steady," warned Matheson quietly as he placed a gentle hand on my forearm. It was silent in the room for a long moment, D. C. Storel's face a rosy hue. I was a little warm myself.

"What exactly caused the explosion, Inspector, has yet to be determined," said Storel. Mercifully his grin was gone. Although not more intelligent, his frown made him appear less stupid.

"No," I answered him.

"Sorry?" he said, frowning more deeply. From grin to grimace in five-point-three seconds: Welcome to Jaggers' World.

"No," I repeated. "I don't know where D.S. Shad was standing when the explosion happened. I wasn't looking in his direction."

"I see," he said, looking once more into his palm. "And where were you?"

I answered him, and with additional questions from Storel I eventually came to realize he was filling out an accident report. I just wanted the ordeal over with as soon as possible. I answered the stupid questions, made no more comments, and closed my eyes when he finally left.

"Jaggers," said Matheson at last, "are you all right?"

"Okehampton is treating it like a range accident."

"Forget Storel, Jaggers. ABCD is pulling out all the stops to investigate this tragedy. We'll get to the bottom of this."

"A four-key organ doesn't have all that many stops to pull, does it, Superintendent?" I opened my eyes, rolled my head gently to the left, and described what happened out at Hangingstone Hill as best I could and urged him to have my bio reader tapped to download my memory record of the event. "Then start the inquiry at this end by tracing the original call. No one out there in the north end of Dartmoor ever heard of a dead bio on Hangingstone Hill, Superintendent—not at Okehampton Station, nor at the army camp. Find out who rang us with the report and from where. Anything left of the cruiser's computers?"

He slowly shook his head. "I'm afraid it's hopeless. Whatever hasn't been

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burned, melted, or shattered has been vaporized."

"Any backups of Shad's engrams anywhere?"

"Nothing we can find. D. C. Parker inquired of North American Biotron—they produced Guy Shad's duck bio for those American insurance advert producers. However, Shad failed to have his engrams on file there or anywhere else."

"Are you certain there's nothing in the tower mainframe?" I asked, already knowing the answer.

Matheson's eyebrows arched. "None of us have our engrams copied into the computer, Jaggers. I suppose we ought, but it's not like our end of law enforcement is violent. Not usually."

"Who is out at the scene?"

"Parker was out there today alongside Constabulary Scientific and Technical. What they picked up out there seems to confirm what Storel said."

With my left hand I grabbed Matheson's uniform lapel and pulled him close. Amidst the fumes of his peculiar cologne, I whispered into his ear, "Tell Parker to watch his back. When he's out there, tell him to watch his back."

"What's going on, Jaggers?"

"It was a trap. We were set up."

I released his lapel, he leaned back, and studied me for a moment. "Army ordinance, the bomb unit, and Scenes of Crime officers all seem to think the explosion was an old dud artillery shell. There's evidence—"

"It hasn't been used as a firing range of any kind for over eighty years, sir. The last of the ballistic artillery shells used there landed twelve decades ago." My thoughts swam reluctantly through my headache. "There was an observation post on top of Hangingstone Hill. Third highest spot on the moor. Makes sense to put an observation post there. Why then would the army shell Hangingstone Hill? The observation shack? Get the army to check their records. On top of that hill is where observers used to stand and see where artillery shells landed *elsewhere.*"

He studied me for a long time, then stood. "Get some rest, Jaggers. The doctor says you'll be back home tomorrow or the day after. Fit for duty in a couple of weeks."

"I can go back to work now, Superintendent. Copied into a walking mech, I can function perfectly well."

"Your body needs to heal, Jaggers, which means you need to be in it moving it around, doing physical therapy or whatever." He gave me that rather startling John Dillinger frown, which was his expression of gentle concern. "There's some head work you need to do, as well. I insist you see that counselor."

I looked up at him. "Superintendent, has anyone notified Val?"

"Of course. As soon as we got the word from Okehampton I sent someone to fetch her. Val and a friend of hers—another cat—are waiting outside the room."

"Nadine Fisher." I felt my heart sink. "She and Shad have been dating."

Matheson's eyebrows arched. "A cat and a duck?"

"Is that any more unusual than a cat and a man being married?" I demanded rather more angrily than intended.

"Sorry. " He thought for a moment. "I suppose it isn't unusual for our times. My wife Constance can be wed to John Dillinger, your wife Valerie can be a cat and married to Basil Rathbone, your partner a duck dating another cat, and my leading inquiry team right now is a frustrated bloodhound and an incontinent gorilla. The world is still just at the beginning of the entire artificial being phenomenon, isn't it?"

"My concerns aren't quite that philosophical, sir. Tell Parker to watch his back." I looked up at him. "Revenge and murder are still with us."

Matheson raised a hand and rubbed the back of his neck. "It's most likely an accident, Jaggers, but I'll get in touch with London ABC, convey your suspicions, see what they suggest."

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He placed his hand on my shoulder. "Terribly sorry about Shad." He nodded, turned, and left the room, leaving the door open. As soon as he left, Val and her friend Nadine came in. Nadine was an orange tabby. My wife hopped up on the bed and Nadine, never presumptuous, climbed up on the chair recently vacated by the superintendent.

"How do you feel, Harry?" Val asked.

"A bit shell shocked." I reached out a hand and stroked her cheek. "Were you terribly worried?"

She cocked her head toward her friend. "I'm afraid Nadine is the one who's having a fright."

"Detective Superintendent Matheson said that Guy is dead," Nadine said quietly, her tone begging for another opinion.

I looked at Nadine, and expression is often difficult to read in a cat. They always look so inscrutably pleased with themselves over some covert triumph. Nadine, though, looked miserable. Her head hung down, and she made a pitiful and barely audible mewing sound. All I could do was lie there looking foolish. I would've resorted to some sort of we'll-get-the-blighter-who-did-this rhetoric, but I feared it would have been heard as falsely as it would have fitted my tongue. Either it was an accident, which meant that gunners and range officers responsible were long dead and gone, or it was indeed set up by person or persons unknown quite skilled at what it takes to stage a crime scene. Either way, that slight reduction in pain referred to by that vacuous term *closure* seemed distant, not just for Nadine, but all of us.

"Why, Harry," said Val as she looked at my face, "you're crying."

I raised my right hand and rubbed my eyes. My fingers came away wet. "I'm afraid I am."

Nadine jumped over onto the bed and the three of us did what we could then for poor Shad, which was bugger all. Perhaps we helped each other a little.

That night, by the grace of a strong sedative, I slept without dreams. The next day I tried walking on my balloon cast and hearing with my new implants. The implants worked perfectly; the balloon cast, aided by sufficient medication, was almost adequate. I avoided my room's telly at first. I knew what would be on. When Shad had been the slapstick funny insurance duck he had children around the world quacking out "aflak-aflak" at particularly serious interludes in classes, during church sermons, political campaign speeches, and funerals. Not entirely restricted to children, moreover. I confess to issuing a rude little "aflak" or two myself back in Metro when the detective chief superintendent would descend from Valhalla and portentously deign to address "you chaps," concerning some high profile case that was drawing heat from the commissioner. One of several reasons I was let go, I suspect.

I eventually gave in and watched one of the reports: a few clips from his adverts and interviews; a laudatory comment from Chief Constable Crowe of the Devon & Cornwall Constabulary, concerning Shad's brief career in ABCD; followed by a computer-generated eulogy delivered by the lizard who had replaced Shad's duck when his insurance firm was merged with another. Instead of his usual nakedness, the lizard was somberly dressed in black tie and suit and oozed virtual sincerity. He concluded his tribute to Shad by making a tasteful pitch for his firm's term life insurance plan. "You never know," he concluded as an image of Shad appeared on the screen, surrounded by a wreath of daisies.

I always hated that lizard.

The newscasters moved over to stories of more pressing matters: the latest mutation of *E. drupi,* the erectile dysfunction virus; the possibilities of latest teen musical fad Cragsuck Funk destroying all life on this planet as we know it; and the electrifying results of the latest government-funded weight-loss study (weight loss can be achieved most effec-

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tively by consuming moderate amounts of a well-balanced diet in combination with a regular program of exercise). I changed the channel and found the same *Law & Order* reruns that had been on the telly the previous time I'd been in hospital.

After a few more tests the following morning, I was released, an ambulance delivering me home finally after a heated debate about the necessity of me being strapped down upon their little roll-around before they could move. Settled in at home, there was an online tutorial for my wireless interface, and with Val's computer I attempted to occupy my mind between headaches learning how to use it. In my first net connection I went to a news site and read the reports on the explosion. Dud shell went off. The deceased was a duck bio who used to be a telly star. Click here for animation. *Aflak.*

I clicked and there were clips taken from several of Shad's adverts. I shut it down, closed my eyes, and ran what I knew: By itself the call from Okehampton Station might have been a hoax. Rather sophisticated hoax, considering the call had to come in with the proper police codes and encryption. Still, it could have been a hoax. By itself the explosion might have been an old dud artillery shell finally grown unstable enough to go up at that particular place and moment. By itself a shell firing short, falling next to an observation post unobserved, and being a dud as well might just have happened. All together, though, it was a bloody stretch of timing that gave credulity stretch marks.

But why? If it was an attempt to kill one or both of us, why so involved? As a sniper-for-hire who had been interviewed after being sentenced once said, "Keep it simple. The more complicated a hit gets, the more opportunity for mistakes, not to mention a smaller profit margin."

Words to live by.

Shad hadn't been with ABCD long enough to have developed a list of enemies. The few cases we had worked together all involved rather genteel malefactors. The most violent encounter Shad and I had was with a Rottweiler natural in Taunton who objected to being parted from his mate, a Dandie Dinmont bio named Flossie whose human engrams happened to be fleeing imprisonment on embezzlement charges. That particular felon had been remarkably grateful for our intercession. My early decades with Metro, on the other hand, had produced a virtual army of murderers, terrorists, and other violent chaps who would've delighted in seeing me blown to pieces. That was long ago, though. Most of the violent ones from my Metro years were either dead, living off their book and motion picture royalties, or dribbling oatmeal down their bibs in prison geriatric wards. None of them, in addition, were bombers. There was an answer somewhere, but I couldn't find it. I took my headache to bed.

Early in the morning on my third day home there was a ring from D. C. Ralph Parker, our mountain gorilla bio detective with the waste management problem. *"The chaps at Scientific and Technical concur with Army Military Police, sir,"* he said. *"As far as they are concerned it was a dud artillery shell that became unstable and simply popped off. They found enough bits of casing to identify the shell: an Excalibur Mark XVII. That's a twenty-five centimeter high explosive smart round for a long range cannon the army used toward the end of the Twenty-one hundreds."*

"What about the chemical composition of the explosive? Has that been matched to the casing fragments?"

"Exact match, sir."

"How'd the shell get next to an observation post?"

"The army can't explain it. Records from that period show which part of which range was used for a particular test or exercise. They show from where

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the shells were fired and where they were supposed to land, but there's no way to catalog short rounds or duds. If the guidance load went out on one of those smart rounds it became just like any other lump. Also, it's the army's opinion that an observer could well have been standing in that observation post during an exercise and not have noticed a short round dud striking nearby and burying itself in the sod. The noise, you see."

"What about the call?" I asked.

"Sorry?"

"The call that came into ABCD regarding a dead amdroid out on the moor, Parker. Did anyone trace it?"

"The call came from a mobile phone out of Okehampton, sir. A bit strange that."

"How so?"

"It's a police mobile number assigned to a Sergeant James Colly, constable assigned to Okehampton Station. On that exact day, though, Sergeant Colly was in Royal Devon Hospital here in Exeter getting his entire heart replaced. He'd been in intensive care there for a fortnight before the operation, which is a substantial piece of surgery I'm told."

"Does make rather a good alibi, doesn't it. Where was his phone?"

"With him, sir. It was among his things in hospital, locked up. Whoever made the call must've duped his police card. That kept the call from being screened out as a hoax."

Had to have been done more than three weeks ago. Considerable planning, highly technical, forensically sophisticated, absolutely ruthless. "Parker, do you have Colly's phone records?"

"Yes, sir. The call to ABCD Exeter was the only call made on that phone for the past twenty-two days. We voice printed the call recording, and that definitely wasn't Colly who rang up the tower to report the dead bio. Very high voice. A child's according to the computer analysis."

"Get a match on the voiceprint?"

"No. Someone not in the system." There was a long uncomfortable pause on the line.

"What is it, Parker?" I said rather more irritably than was polite.

"We have orders from London to drop the entire matter. They've concluded that Shad's death was simply a piece of rotten luck."

"Luck," I repeated flatly.

"Yes, sir. There's some suggestion," he continued, *"that Shad might have set the thing off himself."*

"What?"

"They say he might have touched something out there."

"It was a possible crime scene, Parker! Of course he touched something! That was his bleeding job!" My headache began ricocheting from one side of my skull to the other, and I forced myself to calm down. "Shad's an experienced detective, Parker. When he was a human nat in the NYPD he even had bomb disposal unit experience. He wouldn't beat on a bomb fuse with a hammer just to see what would happen. They can't be serious."

"Serious enough for Dartmoor National Park Authority to consider billing ABCD to have that logan stone put back in its original position."

"Bollocks! Great roiling oceans of bloody flipping bilge!" I closed my eyes as molten steel seemed to pour into my brain pan, all of which left me somewhat suspended between uncontainable pain and unexpressed expletives. When I risked opening my eyes I noticed Val sitting in the doorway. "Sorry, dear."

Her deep aqua eyes studied me for a moment. "Harry, are you all right?"

"Managing, dear. Ralph Parker and I were having a wag on the phone."

"The doctor said getting upset would probably worsen your headaches."

"I'm astounded he took the time from selling his old trusses."

"What?"

"I'm pleased to report my own research supports Dr. Truscott's theory,

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dear. Something else?"

"Don't get cross with me, Harry. I know you're in pain, but don't take it out on me."

I took a breath and let it out. "Sorry."

"Nadine would like to go to Hangingstone Hill. Is that possible?"

"Parker," I said into the handset, "has the scene out at Hangingstone Hill been cleared?"

"Yes sir. Did I hear your wife and her friend want to go out there?"

"Is there a problem?"

"I suppose there isn't any reason except . . . I mean, that's where Shad . . . you know."

"Yes," I answered. "Perhaps it may help Nadine," I offered. "Very well, dear," I said to Val. "I'll see about organizing something."

"Thank you." She turned and padded away toward the stairs.

"Sorry about barking at you," I said to Parker, turning again to the phone. "Didn't mean to kill the messenger."

"Not at all, sir. But about going to Hangingstone—it hasn't rained on the north moor since it happened."

"You mean we may find blood."

"Yes, sir. Shad's and a good deal of your own. A weather front is supposed to dampen things a bit this morning. Perhaps if you wait until tomorrow."

"Val seems to think going there will help Nadine."

"Not for me to say, sir. Oh, while I think of it, if you go, use GPS rather than trying to home in on the prang."

"Has it been removed?"

"No. There's an odd bit of jurisdictional flap with that. The scene analyzer wasn't ours, wasn't the army's, and wasn't one of the constabulary's. Has to be a records glitch somewhere. Who is supposed to collect it up has become a bother, as well. All the same, the signal's dead."

I frowned. "Dead?"

"Day by day the signal grew weaker, then all of a sudden died. The bloody thing can't even maintain memory, sir, much less project the crime scene."

"Who copied it for the inquiry file?"

"That jurisdictional thing again, sir. Everyone assumed that the authority who placed the prang also copied it."

"So no one copied it."

"A proper cock-up," he stated.

I looked down at the Persian rug on the floor, its design filled with happy blues and yellows. Whoever set the trap attached that scene analyzer to the logan stone. That's why the unit's serial number appeared in no one's records. It was a real prang, though, authentic enough to get Shad and me there. It was the genuine article. The power supply, therefore—

After a beat of stunned silence, my headache was temporarily forgotten. "Thanks for ringing me up, Parker. I appreciate it more than I can say."

"Not at all—"

I hung up, stood, and limped down the hall into the kitchen where Walter, our Rent-A-Mech, was finishing up the breakfast dishes.

Walter was one of thousands of the same model mechanical purchased years ago by Exeter's Rent-A-Mech, Ltd. to go in service on a lease basis only to have all of their workers emancipated by Parliament because modified human engram based artificial intelligence was included in the Parliamentary Reform Act of 2132. The mechs, in response, bought the firm from the owners whom they kept on to run the company. All Rent-A-Mechs in the city looked like twentieth-century actor Stephen Fry in his role as Jeeves, had that venerable valet's epidermis been made of brushed titanium. Since the takeover, however, the livery in most cases had been traded in on more casual wear. It depended on the client. Walter wore earth tones and corduroy at our place.

"Walter," I said, "are you free for the remainder of the day? I know you have other clients."

"I am yours to command, sir. If dinner is to be served here at the usual time,

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however, I should begin preparations at around five."

"Can you drive Val, Nadine, and me out to the north moor near Okehampton?"

"Indeed I can, sir. When would that be?" I'd urged him to call me Harry, but Walter said it just wouldn't do.

"Right now. It's rather urgent."

"Very well, sir. I'll bring my electric around, shall I?"

"Thank you."

I hobbled up the stairs to the guest room where Nadine had been staying since the news about Shad. It was smallish, a single window looking over the garden, pale peach walls, and a single bed with a powder blue coverlet. Val and her friend were both sitting on the bed. "Walter's going to drive us out to the moor," I said to Val. "He's bringing his car around now."

"Thank you, Harry," said Nadine. "It's a terrible imposition, I know."

"Not at all." I debated offering my possible piece of news. False hope and such. However, it was either tell Nadine now or at Hangingstone Hill.

"Harry, what is it?" asked Val.

"There is a possibility," I looked at Nadine, "just a possibility, mind you, that Guy is still alive." As they started to speak all at once I held up my hands. "A slim chance, but a chance. I'll explain in the car. Let's get going."

As I stood aside, allowing the two cats to run out of the room ahead of me, I saw—my cautionary probabilities notwithstanding—Nadine and Val both had only heard that Shad was still alive.

Walter's car was an MG ground electric, which would have been cramped had Val and Nadine not been cats. Once we were off the Alphington Spur headed west on the A 30, Walter and I up front and the cats on a blanket in back, I turned half around and explained. "It has to do with the Vader prang—the mounted scene analyzer—at the site. That particular model is about fifteen centimeters long and a bit more than half a centimeter thick."

"What about them?" asked Val. She knew as much about the purpose of prangs as I did, but she knew I was after something else.

I turned to Nadine. "This kind of scene analyzer is arguably the most indestructible instrument in the world, Nadine. The case is made from high-density ceramic composition titanium, and the power supply is designed to take and retain its scene forensic data indefinitely. Crime scenes sometimes need to be maintained for years—even decades. That's what the prang does: It records everything in place at a particular point in time, in detail, and can project that detail upon the scene long after the elements of that scene have changed. Hence scene analyzers must be able to withstand the elements, attempts at tampering, and efforts of miscreants to destroy them. In all my time in law enforcement I have never known a scene analyzer to fail."

"What does this have to do with Guy?" asked Nadine.

"The prang out at Hangingstone Hill failed."

"Surely, sir," began Walter, "if an artillery shell went off next to one of those instruments . . . well, doesn't that seem likely as a cause?"

"Certainly if it failed completely and right away, Walter. But Parker said that the prang's signal at Hangingstone declined in strength over two days, then suddenly died." I looked at Nadine. "I believe Guy might have had time enough before the explosion to copy into one of the smaller mechs and has since been drawing power from the scene analyzer."

"If that's true," said Val, "Guy must be able to move about. Why didn't he let Ralph Parker or the police know when they were out there?"

"I'm not certain. It might have to do with concerns about being observed."

"By the person or persons who planted the bomb?" asked Walter.

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"Yes."

"Sir, if I may?"

I nodded permission.

"Thank you, sir. Given possible post-incident observation, is it likely that such an offender may have a continuing interest in any subsequent inquiry or activity concerning said hill, including ours?"

"Quite likely," I answered.

"Might I suggest, then, we enter the moor farther to the east instead of taking the obvious route through Okehampton past the army camp?"

"Can you find the hill using another route?"

"Indeed I can, sir. As I was driving I downloaded the Ordinance Survey map of the area."

"Good thinking, Walter. Very well, we are in your capable hands."

"Very good, sir."

He got off the motorway at one of the South Zeal exits, went through the villages of Sticklepath and Belstone, where we came onto a brain-shattering unpaved track called Tarka Trail, which took us up onto the moor just as a light rain began falling. As we traveled the trail Walter identified the features we crossed: Scarey Tor which wasn't; East Okemont River ford, where we almost became mired; a boggy stretch between East Mill Tor and Oke Tor, where we forded the tributaries to the previously forded East Okemont River, climbed and crossed Okement Hill, then traveled down the hill to ford one of the River Taw tributaries. Following that, the car climbed the north end of Hangingstone Hill, where we at last came to a stop a few meters north of the old observation post where several other ground cars and two Air Rovers were parked. Walter parked his MG between a late model gray Ford Virgo and a burgundy Renault Festiva that had seen better days. The moment the MG stopped, Walter had a headache preparation ready for me. As I drank that, Walter exited the car, held his seat forward for Val and Nadine, and came around to the passenger side, umbrella in hand for me. Terribly efficient personnel at Rent-A-Mech. I cannot recommend them too highly.

The others on the hill, approximately twenty or so, appeared to be curiosity seekers from Okehampton and nearby villages. Families with children, individuals—no one appeared bothered yet by the developing rain as they eagerly searched for a telly star's signs of death. As I waited for the headache remedy to take effect, I noticed a boy of eleven or twelve, blondish and chunky, squatting down and examining the grass at his feet almost one blade at a time. Such concentration would have been the envy of any Scenes of Crime officer. "What are you looking for, lad?" I asked.

"Feathers, sir," he answered, not looking up. "White ones."

I was about to point out that Shad hadn't been a white duck when a little girl with dark hair, big eyes, wearing a blue rain jacket and little blue wellies, saw Nadine and called out to her parent, "Oh, Mummy, may I play with kitty?"

"Ask the gentleman, Pearl," said a large woman in her forties, quite disturbingly dressed the same as her offspring.

Pearl approached me. "Sir, may I play with your kitty?"

"Ask her," I answered.

The girl frowned as she turned toward Nadine. Val, however, intercepted the girl's inquiry and said to her, "Perhaps later, dear."

Pearl ran off to her mother's side declaiming frightening things said to her by those horrible bio cats, Pearl's mum glared at me, and mercifully it began raining in earnest. Several souvenir hunters made for their vehicles. "Into each life some rain must fall," observed Walter.

I glanced at him. "Shakespeare?"

"No sir. Henry Wadsworth Longfellow."

"Let's see if we can find Shad."

After half an hour of steadily increasing rain, an unpleasantly chilly wind from the west encouraging the appreciа-

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on of warmer climes and more shel-ered endeavors, all of the other seekers ad departed. It was curious watching as ıe rain seemed to heal the place where ıe explosion occurred. The stone dust ashed from the blasted granite edrock, clumps of earth eroded, a mud-y pool began forming in the bottom of ıe small crater.

"I wonder how long it will take, sir, efore all signs of what happened here re swallowed," said Walter, still holding ıe umbrella between me and the rain. ly coat had water repellant pretensions ıat were also eroding as the rain contin-ed.

"Months," I guessed. "Perhaps only ays." I looked over the hilly expanses of ıe former artillery range. Heather, peat ogs, rocks, the view of the edges soft-ned by the great solvent, rain. The only vidence that anything had ever explod-d out here was at our feet and fading as ve watched. "Existence is such a transi-ory thing, Walter, our marks of passing o slight. In the midst of living, though, fe seems so enduring, our accomplish-ıents gigantic and eternal. Yet when leath touches us, this sense of perma-ıence evaporates like the illusion it is. 'erhaps that's why so many of us hang ınto life so."

"Lingering in hopes of permanence, ir?"

"The return of its illusion, perhaps. Do 'ou keep a backup copy of your en-grams, Walter?"

"Indeed I do, sir. Rent-A-Mech insists ın it. Perish the thought something hould happen to me. Should it, howev-r, my training, experience, and, most mportantly, client preferences and re-uirements won't be lost. Neither will I. \ new can, and at most I'd lose a day or wo. It affords me a measure of security ınd protects the firm's client informa-ion." He faced me. "Weren't D. S. Shad's ngrams backed up?"

"No."

"Dear me, sir. Why is that, if I might ınow?"

"A half dozen excuses—it takes time, too bothersome, uses too much memory in the mainframe, and so on. Most bios don't do it, though, because it feels creepy."

"Creepy, sir?"

"That's Shad's word. An uneasiness. I think, because we're originally human naturals, we hold onto this illusion that we're unique irreproducible beings. Backing up engram imprints gives in to the fact, all this protoplasm notwith-standing, we are but machines. It's humbling."

"Are your engrams backed up, sir?"

"No. And, yes, the reasons for not doing it seem sillier with each passing moment." I nodded toward the crater. "We'd best finish our search before the entire moor erodes into the sea. Walter, we could cover more ground if you'd agree to join in."

"I would be happy to, sir," he responded lowering his voice, "However, Mrs. Jaggers told me she'd have my gears for garters if I allowed a single drop of rain to fall upon you."

"Since I'm already soaked through, dear boy, I'd say you're already doomed."

"Before my imminent disassembly, sir, shall I engage in a bit of exploration then?"

"The wages are the same in either case." I pointed to the opposite side of the crater. "Go down slope until you run out of loose clumps of soil and other debris from the explosion. Go a couple meters beyond, then circle the edge of the debris field, moving toward the center with each circuit. I'll start in the center and work my way out. Look in, around, over, and beneath everything. And thank you."

We walked the coil for more than two hours, turning over rocks and clods of earth, not finding Shad or anything into which he might have copied himself. I reached the displaced hanging stone before Walter. When I examined the scene analyzer I could tell someone had tried prying the thing free of the rock, which

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showed crude tool marks. I suspected souvenir hunters. Our culprit would possess the tool necessary to remove the instrument from its site.

My wireless interface detected no signal at all from the prang. I stood and looked toward the northwest. The view took in vast distances, the boulder-pocked flanks of Yes Tor filling the far distance. But what I could see was but a small part of the moor. If Shad had copied into a mech and had gone for help he could be quite a ways from Hangingstone Hill. He could have run out of power before reaching help. He could have been caught in the open.

Suddenly I felt a chill and began shaking as I pulled my coat about me. I was soaked, my ankle hurt, and my head was splitting. I was very tired and possessed of an overwhelming desire to lie down in the wet heather, pull the rain up over my head, and let sleep take me.

"Sir, if I may?" said Walter.

I smelled hot tea. When I opened my eyes and looked, Walter was holding out a steaming cuppa. I took it in both hands, felt it warm my palms, then took a sip, the healing liquid heating my core.

"Thank you. Where on earth did you get this?"

"I had a few moments before your party made it to the car, sir, and packed a snack. I arranged a bit of shelter on the east side of that stone building at the top of the hill."

He helped me along, and by the time I had finished the tea, I was mobile again, my wits about me, but a terrible pain in my ankle. The wall on the east side of the observation shack was in severe disrepair, but Walter had taken a few rocks and boards and constructed a makeshift shelter off to the side of the shack, within which was a plank bench propped upon two flat stones. He helped me down upon the thing easing the pain in my ankle considerably. Before I could thank him, he held out a tray of small sandwiches with one hand and his carafe of tea in the other. I had three of the former and a refill from the latter as h warmed the enclosure with his wrinkl remover.

"By the way, sir, I found those electi cal components and pieces of met upon the bench beside you during m search."

As I was chewing on an absolutely d licious turkey and avocado sandwich, examined what looked like pieces to homemade remote detonator and fra ments of bomb casing. Walter ha placed them in sealed plastic envelope dated, site located, and signed. I chance to look up and saw between the board above. I was being protected from th rain by a plastic sheet decorated with im ages of hundreds of mice. I swallowe my mouthful and said, "Walter?"

"Yes, sir?"

"Where did you obtain that plasti sheet?"

"From the Marks & Spencer catalog sir. I originally intended it to serve as ground cloth for our picnic here. Be cause of the inclement weather, howev er, I thought this application more prac tical."

The mice on that sheet weren't Mick ey or Minnie, or even Mighty. They were, instead, a quite realistic vermin in festation of Biblical proportions. "Mice Walter?"

"Yes, sir. It was for Mrs. Jaggers anc her guest. I hope you don't object."

"No. No, Walter. Not at all." I looked away from the sheet. "Speaking of Va and Nadine, do you know where they are?"

Just then a strange distant voice sang out, "Nadine, honey is that you?"

From the other side of the little stone building I heard Nadine call out, "It's *Chuck Berry!*"

"Help me up, Walter. That's Shad!"

Before he could get me to my feet, Nadine ran into the shelter followed by Val. In Nadine's mouth she carried a small object that resembled a micro—the lipstick sized forensic mech we used for getting past reporters and into really tight

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laces. She jumped up on the wooden lank and deposited the micro in my and. "Guy is in this thing, Harry, isn't e? Guy sings that song to me. Because f my name. That's Chuck Berry's voice."

"Yes," I said as I examined the tiny ve-icle. All of the black paint was gone om the micro's port side, and one of ıe tiny claw grapples up front was bro-en off. The other forensic instruments, owever, looked serviceable. The tiny lashing red power readout on its front nd indicated an occupant coming off tandby. "He's in there, Nadine," I said.

The micro energized fully and rose ıto the air, its chipped lens aimed at my ace. "Jaggs. It's about time you got ıere."

"I say, look what the cat dragged in," I esponded happily.

Hovering, the micro turned around. Hi, Walter."

"Very good to see you, sir."

Aimed at my wife, Shad said, "Hi, Val."

"It's so good to find you alive, Guy. We vere so worried."

"And therein lies a tale. But first," he lid a middling job of rubbing the micro's ort side against Nadine's left whiskers ınd cheek. "I really missed you."

"Nadine's the one who suggested oming out here," I said.

"In that case," he said to Nadine, "you lefinitely pulled my engrams out of the ire."

"Guy," said Nadine meekly, "your lucky suit. I'm afraid it's gone."

"Yeah. I've been finding pieces of my-elf scattered all over the north end of his hill. That rat, too." He faced me. "All found of yours, Jaggs, was a lot of blood." He did a quick scan of me. "Bust-ed ankle, ribs, ear implants, and a cut hroat. You got off light. Which reminds ne: Is there anyone else on the hill be-ides you four?"

"There were more than a dozen, but hey all went home, Guy," answered Na-line. "It's raining."

"Harry," said Val crossly. "You're soaked and you'll catch your death."

"Better I should catch death than it should catch me," I answered with a smile.

"Walter—" she began.

"Stop fussing," I said, "and you're not to reproach Walter. He did what he could to keep me dry within the bounds of my cooperation."

"If that's all settled," said Shad as he rose slightly and faced Walter, "Brother mech, you got an AH8 port adapter in that can?"

Walter held up his left pinky finger. "I do indeed, sir."

"If you can spare a couple of elec-trons, I could use a boost."

"Certainly, sir."

Shad rotated up slightly, caught a view of Walter's special tablecloth, and shot down to the ground as he cried out. He studied it for a moment and slowly turned until he was looking at me.

"A little treat Walter purchased for Val and Nadine," I explained. "A feline snack motif."

"Mice?"

The cats looked up at the improvised roof. "Why, Walter," said Val. "It's very thoughtful."

"Ever so elegant," Nadine joked ami-ably.

"Yeah, man," Shad said as he warily moved toward Walter. "The bee's knees."

After Shad's micro was fully charged and Val and Nadine were happily eating the mouse morsel stuffed pastries Walter provided, I tried a general wireless trans-mission. *"They operated on my ears and I went wireless."*

"And another dinosaur bites the dust," Shad said out loud to me. Turning to Wal-ter he said. "Do you have wireless?"

"I do indeed, sir."

"Would you send a little transmission to Jaggs telling him how great his new ears are?"

"Very good, sir." To me he transmitted, *"Your signal came in five-by-five, sir. Do you enjoy the feature?"*

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"Haven't quite gotten used to it," I answered. To Shad I said aloud, "What's afoot?"

"Nicely put," rhymed Shad. Val and Nadine were both looking up from their mouse morsels sensing something amiss. "We're being observed," Shad announced to us all. "It's electronic and optical surveillance. I don't think the guy staking out this location can pick up low level sound or bio or mech receivers at the range he's at, but wireless he gets."

"Who?" asked Val.

"This is going to sound crazy," he said to Val, "but it might be the NYPD."

"I say." I must have looked rather surprised. In any event, I certainly felt that way. "What led you to that conclusion?"

"The rat said something to me right before all hell broke loose. When you were on the phone trying to make sense of the report we received, Jaggs, I went to the cruiser and copied into this micro. From there I went directly to our alleged corpse. I was just about to do a scan on the deceased when the rat opened his eyes, looked behind me, then looked directly at me and said, 'Hi, cheese eater.'" Shad issued the rat's words in a falsetto voice, replete with scorn and American accented syllables.

"What happened then?"

"The rat moved one of his front feet and I began getting the hell out of there. A second later it went boom. By the time this mech rebooted and I managed to dig my way out from under some turf that landed on me, it was dark, the area was ringed with crime scene tape, and everybody was gone."

"Is there some significance in what the rat said?"

"Yes," answered Shad. "Cheese eater is one of the more affectionate names NYC cops use to refer to members of the rat squad: Internal Affairs Bureau." He turned to Nadine. "IAB takes down crooked cops."

"Were you ever in Internal Affairs?" I asked him.

"No. But I never took a bribe and among some cops that's prima facie ev dence you're chewing cheddar with th whiskered set."

I gently shook my head. "That make no sense. You're thousands of miles, couple of years, and several careers awa from New York and its police force. Wh try and kill you now?"

"All I can think of is some old crooke cop went a little dingy in the head an decided killing me was the answer to al his problems."

"Why didn't you put in a call for help? Nadine asked.

"The blast damaged this micro's anten na. I tried a call and my transmission dis tance is down to under three kilometers I had my scanner on looking for loca traffic in case the cops, the army, or a hiker with his cell on came near when *received* a transmission." He looked a me. "It sounded like a generated voice All it said was, 'I received a weak signal The turkey might not be done.' Just like that. Only a key click for a response."

"That doesn't sound friendly," ob served Walter.

"That was my take on it. Both trans missions were clear, and I got automatic azimuths on both. I didn't attempt any more calls, but I traveled a few meters so I could triangulate the transmissions should whoever was watching me make another call. As soon as I moved, though, there was another signal, same voice—very high. Familiar but can't place it. The bearing showed it came from that tor just north of us."

"Steeperton?" asked Walter.

"Yeah. One word: 'Movement.' There was a long silence, then came the response. A voice that didn't sound generated at all said, 'Finish it.' Both communications were on hand radio frequency."

"You get a fix on the other party?" I asked.

"A village due east of here called Gidleigh. Nothing since, and that was three days ago. I know the guy's still on Steeperton, though. Every so often he down-

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loads some information and I can pick up his satellite address. To conserve my charge I go hide in an old piece of tubing on the roof and go standby. My boy on Steeperton visited here searching for me when I was shut down. That's when he sucked the rest of the charge off that Vader prang."

I frowned. If it was a hitter, the fellow's reckless perseverance was remarkable—unless he was expendable. "Dependable and expendable," I said. "Are you thinking what I'm thinking?" I asked Shad.

"A toaster."

I nodded.

"What's a toaster, dear?" Val asked me.

"Originally it was a kind of robot certain terrorist, gang, and government types used for settling old scores and eliminating troublesome personages."

"Do you mean a hit man—person, thing . . ." She looked at Walter.

"I believe *assassin* will do nicely, madam." He looked at me. "If I may, sir?"

"Please."

"It has to do with Modified Engram Based Intelligence Technology—MEBIT for short. The original point of artificial intelligence, of course, was to produce a mentally able, efficient, obedient work force that would do what it was instructed and make no demands."

"Slaves," said Nadine.

"Exactly, miss. As the U.S. Supreme Court's majority opinion in *Grant* v. *Hudder* found—"

"Walter," I cautioned gently.

"Forgive me, sir. In short, madam, the modified part of MEBIT intelligence was ruled illegal in the States, which prompted Parliament to do the same here. I can still recall the day all of us at Rent-A-Mech received our patches."

"Instead of MEBITs," said Shad, "they're now EBITS. A baseball joke in there somewhere—"

"About the toasters," I interrupted.

"Yes, sir," Walter turned toward Nadine and Val. "MEBIT operated beings, bios and mechs, are blocked from disobeying, disagreeing with, or altering their instructions. As killers it makes them highly intelligent, persistent, and resourceful, if a trifle rigid. If apprehended." Walter looked at me.

I thought about that for a moment, remembering several famous cases from when I was with Metro. "Actually, they cannot be apprehended. If old bill is closing in and it looks bad for the dex, he zeroes himself out. Scrubbed clean."

"Some New Jersey gangs used to rig theirs to explode," said Shad. His micro faced me. "Jaggs, I could've run off that Vader prang for another couple of weeks. I thought the toaster drained it to force me out, but dexes are high energy. Maybe he's running low, too."

"How does he know you haven't left the hill or zeroed out yourself?" I asked.

A mischievous little cackle came from the micro. "You know how superstitious most mechs are?"

I looked at Walter. "Are we being insensitive?"

"Not at all, sir. D. S. Shad's observation is quite true, although bios with artificial intelligence are the same as mechs in this regard. My therapist ascribes the phenomenon to the shortcuts taken to devise MEBIT. The early versions of artificial intelligence weren't very artificial in that the basic engram patterns were simply copied from various humans. They erased all the identity memories—life experiences, embarrassing encounters at summer camp, credit account numbers, that sort of thing—but there wasn't any way to eliminate the feelings connected to those memories."

"I cannot imagine what that must be like," said Val.

"It is quite like being haunted, madam," stated Walter. "Even with the patch, all EBIT AI's are filled with feelings to which they cannot attach experience. It gives one the continuous sense of having misplaced or forgotten things of importance. Often this feeling manifests itself as a form of schizophrenia. In my case I always felt as though I was be-

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ing watched. When voices began talking to me, I sought a therapist. Many AI operated beings believe in ghosts. For some the spirits even appear to take corporeal form."

I looked at Shad. "And?"

"Well, I've been transmitting little ghost plays nights to my buddy over there on Steeperton."

I cleared my throat and said with a ghostly timbre, "'I wear the chain I forged in life. I made it link by link—'"

"Nothing Dickensonian. He's been looking me up on the net while he's sitting there in his little shack in the dark. So nights I've been sending bits from my old insurance commercials." He treated us to a series of ghostly *aflaks* and we all laughed. "One of the visitors yesterday left a blue candy wrapper on the ground. Last night I put my illuminated end in the wrapper and gave him a light show. "I don't know if I scared him, but if he buys a policy I need to talk to the company about my commission."

"Weren't you afraid of frightening him off?" asked Nadine.

"He's still got a job to do," Shad answered flatly. "What I've done is let him know the job may not be finished. He'll keep at it until either his battery dies or the fellow in Gidleigh calls him off."

"Where could he have obtained a live artillery shell? An antique? How could he sneak it into the country?"

"Good questions," he answered.

Someone rang me on my wireless. Unlike the mech wireless, not at all an unpleasant sensation. Instead of buzzing, vibrating, or playing some annoying tune, the knowledge that I had an incoming call simply appeared in my head. As Val and Nadine returned to their pastries, I motioned for Shad and Walter to listen in. It was Matheson.

"Jaggers. How are you doing, old fellow? Enjoying your time off?"

"Well enough, Superintendent. The family and I are having an outing—a picnic."

"Excellent. Fresh air, a good hobble. Best thing for you. I have a few things regarding that matter out at Hangingstone." I debated cutting him off in respect to our listening audience on Steeperton, but thought better of it.

"Very well, sir."

"Sci-and-Tech finished running the IDs on the DNA collected at the scene. Shad, of course," he began.

"Yes, sir."

"The rat amdroid bio, though, is a Fantronics, Ltd. product. That particular rat was purchased by a costumer: Celebrity Look-alikes of Bond Street, London."

I looked at Shad, a quizzical expression on my face. "Celebrity rat?" I mouthed.

"Ben," said Shad. "The rodent lead in the motion picture *Willard?"*

"Go on, sir," I urged Matheson.

"The customer was a D. Lipper of Kensington. I glanced at Shad in his micro. Before he became a duck and a telly advert star, back when he had been in the NYPD, Guy Shad's name had been Donald Lipper. Hard to read emotional reactions off the chassis of a micro.

"Interesting sense of irony," observed Shad.

"He paid the full amount in cash," Matheson continued. *"His money was good, name and address both phonies. No description."*

"Superintendent, what about surveillance records?"

"For what they believe are obvious reasons, Jaggers, Celebrity Look-alikes do not allow cameras of any kind on premises. We're running the records of the street cameras right now, but Celebrity has hundreds of client visits, inquiries, pickups, and deliveries every day. Given this fellow's proclivities, he was probably in disguise when he rented the rat meat suit."

"What about the person who handled the sale? Someone with a downloadable memory?"

"A human natural, as our luck would have it. The agent who handled

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the sale can't remember one rat customer from another. Rat bios are quite popular costumes for some disquieting reason—school outings, club meetings, university bashes—that sort of thing. The fellow didn't copy into the rat suit on the premises. Presumably he has the use of a stasis bed elsewhere. I may be jumping the gun, but I'm reopening the inquiry as a possible homicide."

I glanced down at Shad in his flying lipstick. "Thank you. Is that it, sir?"

"An additional unrelated matter. Quite interesting. Birdshot was found in—among Shad's remains."

"Yes, sir," I answered, looking at Shad's micro. "When Shad was an officer with Northern New England Wildlife Protection I believe he was wounded during a duck hunting season."

"Really. Well, Jaggers, it appears that two of the pellets have been positively matched to a registered microscopic barrel map of a shotgun purchased in Burlington, Vermont, eleven years ago. The purchaser was a bloke named John Quinn."

"John Quinn, you say?"

"Yes. He was once in law enforcement in New York City. Chief of detectives, actually. Eventually became commissioner. Seems to have gotten into politics. Running for state governor or something. Don't suppose there was anything they could do about a duck hunter shooting a duck in duck hunting season, eh?

"No, sir."

"Well, that's all I have, Jaggers. Enjoy your picnic and best to Val."

I bid Matheson good-bye and looked at Shad. "John Quinn?" I said.

He was silent for a very long moment. At last he played his memory recording of the rat's last words. "'Hi cheese eater.'"

I looked at Walter. "You watch the American news. Have you ever seen this Quinn on the telly?"

"Yes, sir. Former police commissioner Quinn is frequently invited to appear on American news programs to reflect upon various law enforcement issues. Polls place him at least twenty points above his closest rivals in the coming primaries. There is also speculation that after capturing the state governorship his goal is the White House."

"What do you think of the cheese-eater recording?"

Walter turned toward Shad. "May I hear it again, sergeant?"

Shad played the recording.

"Sir," said Walter, "that sounds very much like John Quinn doing his impression of Mickey Mouse imitating Bluto with a New York accent."

"Bluto?" asked Nadine looking up from her mouse morsels at Shad.

"Popeye's rival for the hand of the fair Olive Oyl," said Shad. He repeated the cheese eater recording, then played the mysterious transmission he had picked up from Gidleigh: "'Finish it.'"

"Is that Quinn?" I asked Shad.

"Yeah. I think so." The micro faced me. "John Montgomery Quinn. I don't get it, man. I was even going to vote for the guy." Shad flew in slow, measured circles. "Damned near kills my partner when he blows me up with a bogus rat. Two years ago he shoots me in the ass with a shotgun. Twelve years ago . . ." Shad's micro stopped moving, hovered motionless for an instant, then streaked out from beneath the shelter. I had Walter help me up and serve as a crutch as I followed. The rain had stopped leaving a dank heaviness to the air. When I found Shad he was down at the original position of the hanging stone, his lens aimed at the pool at the bottom of the crater.

"What is it, Shad?"

He was silent for a long moment. When he spoke his voice sounded strangely vulnerable. "Jaggs, are you familiar with an old Al Pacino cop flick titled *Serpico?*"

"A cop classic. What law enforcement officer hasn't . . ." My voice trailed off as I realized to what Shad was alluding. The real Serpico wouldn't go along with the

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other cops in bribe taking. His fellow cops, uncomfortable with such reckless behavior, set up young Serpico to be killed. Back in the NYPD, I-never-took-a-bribe Detective Donald Lipper was asked to back up some other cops in taking down a fugitive. Detective Lipper was first one through the door. As Shad put it the day I met him, "The next thing I knew all the bullets in the world were headed in my direction, and I was fricassee."

"When I was killed," said Shad, "Chief Quinn was the head of the Detective Bureau. Nothing left of me but memory. Chief Quinn came by the hospital to talk with me about coming back to the force when I'd copied into my replacement meat suit. That's before my agent got me the duck gig. Funny thing, though."

"What?" I asked.

"On that visit Quinn accidentally knocked over a cup of coffee into the chassis of my memory unit."

"Embarrassing."

"Yeah, not to mention lethal. Lucky the hospital kept patient memory units on continuous sync with its main engram bank."

"Lucky. I say, Shad, Quinn wouldn't happen to have bomb disposal unit experience, would he?"

"Funny you should ask. Thirty years ago John Quinn started out as a firecracker." He paused a moment, then said, "Four attempts at killing me and still at it."

"One must admire the fellow's resolve," Walter observed.

"I don't want to jump to conclusions, Jaggs," said Shad, "but I'm beginning to suspect Quinn wants me out of the way."

"Is there some reason?" I asked. "Do you have anything on him?"

"Other than a couple of attempts at killing me, I can't think of a thing. I know five or six really crooked detectives, though. I'm guessing if they had to sit in front of a committee they could put a substantial knot in Quinn's political panties."

"I suppose we ought to do something about it, old fellow—I mean before candidate Quinn reaches the White House, attains control of a brace of plasma bombs, and accidentally vaporizes Devon."

Shad turned and aimed his lens in the direction of Steeperton. "Unless we can convince that dependable expendable fellow over there to roll on his employer before he zeroes out, all we'll be left with is a dead hunk of machinery and a prime suspect off scot-free."

"What do you suggest?"

Shad's micro looked at Walter. "When I was hooked up to Walter, getting my battery topped off, I got a look at his package. You know he's got more than two hundred thousand recipes on file?"

"Any involving duck?" I asked Walter.

"One hundred and sixteen, sir. All quite excellent."

"He's got some other stuff in there, too, Jaggs. Gives me an idea."

The time and power requirements of Shad's plan left very little charge on Walter's MG and not a great deal of light left to the day by the time we finished preparations. Afterward Walter drove us down the hill and parked the car where the track came in from the Taw Head ford, the last of the rain clouds in the east reflecting the setting sun's light. Val and Nadine remained in the MG equipped with a cell phone whose preprogrammed number for a police ambulance could be entered with the stroke of a single paw. Walter, Shad, and I continued north. Shad hovered, Walter walked, and I leaned rather heavily on Walter as I limped along. In twenty minutes or so we reached a gentle track that came up the southwest side of Steeperton Tor. Twenty additional minutes of climbing, slowed by having to wait for me, and we were at the top, looking across massive stacked granite plates of the tor to the shed-roofed stone observation shack upon a rise at the north end of

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the rocks.

The roof looked to be in much better condition than that of the shack on Hangingstone Hill. I turned back and looked toward the southwest. Hangingstone was a hundred or more meters higher than Steeperton. The air was still and cool. At this distance the shack on Hangingstone was but a darkened dot on the horizon against a sky of delicate pinks rapidly being swallowed by the darkness of the approaching night. It was quite moving. I glanced down at the MG, another dark dot, and imagined Val in there waiting for news of how all this would end.

"Jaggs?" called Shad.

I turned around. Walter was looking at me and Shad was hovering next to him, also looking at me. "Sorry. Getting a last look at things. After all, I am the one who doesn't have a copy back in Exeter."

"Walter and I could go in alone—"

"We are agreed," I interrupted, "that my presence could well tip the scales in favor of the toaster's cooperation?" I looked at Walter.

"Yes, sir. That is true. MEBIT conscience is suppressed, but not eliminated."

I looked at Shad.

"Yeah, great if Walter's right about yon toaster. How about it, Walter? You got a lot of experience with killer mechs?"

"I'm afraid, sir, the only toasters with which I have experience are designed for sliced bread, crumpets, and such." Walter looked at me. "Sir, I could be dead wrong."

"Nicely put," said Shad, turning toward me. "Jaggs, we could wait for a properly equipped team to come and deal with the Terminator. No muss, no fuss—"

"—And no witness," I completed. "To change plans now would require time, which we are running out of rather rapidly. Gentlemen, every now and then one simply needs to roll the dice."

"Would it be crass of me, Balloonleg Harry," asked Shad, "to point out that right now you're on your third meat suit, which itself is getting just a little bomb worn around the edges?"

"Caution," I answered. "is just another way of saying I'm not sure of what I'm doing."

Walter looked at me. "Sir, forgive me if I'm speaking out of turn, but doesn't that rather accurately describe our current predicament?"

"I'm afraid it does, and it is quite tactless of you to make a point of it. I should complain to your employer."

"Employee-owned company, sir," said Walter. "I am my employer."

"Then consider yourself notified." I pointed toward the shack. "Let's go."

The stone shack, according to a sign affixed to its newish steel door, was maintained by the park authority to house emergency medical and survival supplies for hikers stranded by freak storms. I opened the door and it swung in. No noise. No motion. Very little light inside. Outside light was prevented from coming through the windows by flattened pieces of pasteboard. There was a battery-operated light hanging from the center of the roof, but it was missing its batteries. Shad turned on the micro's illumination system. The south wall was filled up to the blocked window with shelves containing first aid kits, packaged blankets, and cases of bottled water and energy bars. Like the battery operated light, all three torches and a radio had been stripped of their batteries, all of which now lay discarded upon the cement floor.

Against the back of the shack, seated in the shadows upon a sleeping bag roll, was the figure of a quite small person. Shad illuminated the figure of a young girl who sat motionless, her eyes open, looking like an old-fashioned porcelain doll on a gift shop shelf. She was clad in pale green sweat pants, chestnut hiking boots, and a darker green top jacket. "I can still read her receiver," said Shad,

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"but she's running on empty."

"She seems familiar," I said.

"Shirley Temple, *Rebecca of Sunnybrook Farm*, 1938. Jaggs, she's close to zeroing out."

"Walter?"

"Yes, sir."

Walter moved next to the girl and knelt, light emanating from somewhere on his chest. He reached with his right hand behind her neck, felt around for a moment, then said, "I've found the port, sir. It's a KV12."

He plugged in and the girl's eyes blinked. She seemed to freeze for a second, then her gaze darted in Walter's direction. "I'm giving you a bit of a charge, miss," he said cheerfully. "You seemed a bit down."

"In your dreams, Tick Tock. It'll be a cold day in hell before a bucket of bolts like you gives me a charge," she said with a definite note of sarcasm in her voice. She didn't pull away, however. Instead she looked at me and frowned. As she moved her gaze to Shad's illuminated micro she stiffened.

"Before doing anything rash," I said, "I would point out that Guy Shad's engrams, current as of two hours ago, have been copied to Exeter, as have our friend Walter's. Mine, on the other hand, have not."

Her gaze traversed the three of us again, stopping on me. "Who are you?"

"Detective Inspector Harrington Jaggers, Devon ABCD. In the micro is D. S. Guy Shad, and the fellow who is providing you with an increased difference in potential is our friend Walter Cogg." Walter nodded.

"I received the transmission, but couldn't read the encryption code," she said to Walter. "Industrial?"

"Yes, miss," said Walter as he removed his hand from the back of her neck and stood. "Rent-A-Mech, Ltd., at your service. It would never do to let competing mechanical service establishments access to our client information, would it?"

"Rent-A-Mech," she repeated without humor.

Walter nodded at me and stepped back.

"I should add," I continued, "detectives from Artificial Beings Crimes and officers of the Devon & Cornwall Constabulary are at this moment descending upon the village of Gidleigh to place John Quinn under arrest for attempted murder."

Her gaze fixed on me. "I have an eight percent charge, Inspector Jaggers," she said. "That's more than sufficient to eliminate all three of you, warn my factor, and effect an escape."

She fell silent, stared at us each in turn, and shifted her gaze to a dark corner. She sat there, staring and immobile, for what seemed an eternity. At last she turned her head and faced Walter, her forehead wrinkled in what appeared to be anguish. "What was it?" she asked "When you put that partial charge in me, what else did you put in?"

"A little upgrade, miss: a patch on your MEBIT imprint."

"A virus?"

"No miss. The patch simply removes all the artificially implanted choice restrictions MEBIT put on your engram set. You are now an EBIT."

It took her awhile to absorb that. Few contemplate freedom's meaning until they lose it. How much more profound it must be for one who never had it or even contemplated it to become suddenly free—to suddenly have a full sense of right and wrong. Instant complications. "You mean I can . . . I can disobey."

"Yes, miss. It is now your choice."

"And your responsibility," I added quickly. I thought about mentioning how she now came under a different set of laws. Before she was a toaster—a tool no more responsible for those she killed than a knife or gun. Now she was like the rest of us—responsible for her choices and filled with anxiety for that reason. I thought about mentioning it, but I felt she already suspected. It frightened her.

"What is your name?" asked Shad.

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"Alice." She wrapped her arms about herself and looked down at the floor. "Alice Blue." The expression on her angelic face hesitated between fear and anger. "Missions, work to do. Orders. No questions. I had no doubts or fears. I knew what to do."

"What about ghosts, Miss Alice?" asked Walter.

"All MEBITs have ghosts," she said dismissively. "You learn not to pay them any mind. Ghosts are nowhere as terrifying—" She slowly shook her head. "I'm seeing things so differently." She rubbed her eyes and leaned back against the stone wall as though her own weight had suddenly become an intolerable burden. "You have no idea of the things I've done—that I still have left to do. I have a job to do, duty, *a purpose.*"

"Change the job," I said. "Find new work, a new duty, choose a different purpose. That's the power you now have."

She stood and was rather small. Beautiful child, a head full of pale brown curls. What an assassin she must have made. Who could look at that and see death coming?

"Why are you three here?" she asked. "You could have destroyed me or simply let me zero out." She held her hands to her face. "My head. I have a head filled with nightmares, a heart that wants to cry, and no tear ducts." She lowered her hands. "What do you want of me?"

"For myself," I began, "I want you to give information to the authorities on your arrangement with John Quinn and testify to it in court. Then it will be time to explore all of the other times you were used to commit illegal acts by testifying against your former masters."

Shad said, "I'd really like to know why Quinn is so obsessed with killing me. Why this elaborate plan?"

Alice Blue looked at Walter. "As for me, Miss Alice," he said, "I'd like to give you the name of my therapist. He may be able to help you sort out some of those nightmares."

"Kill you three or start a whole new existence; is that about it?"

Shad, Walter, and I looked among ourselves, shrugged, agreed, and nodded. "Yes," I said to her. "That's about it."

"The tin man and the flying lipstick are just suits," she said, indicating Walter and Shad. "Their engrams are safe in Rent-A-Mech headquarters." She pointed at me. "All of you that is you is right here. Correct?"

"That is correct," I answered.

"What if I kill you?"

"Then you'd become a murderer."

She held out her hands. "What do you think *I already am!*"

"You were used for the commission of terrible acts, Miss Alice," said Walter. "You now have the ability to become the means through which those acts are made right. You can *choose* to bring those responsible to justice. Before you were a tool; now you are only a tool if you choose to be."

"I can choose to kill." She looked at each of us in turn, her expression softening to become one of awe. "You all have that choice," she said. "You could have killed me."

I couldn't tell if she was going to cooperate, go catatonic, or self-destruct. Just then I felt something brush my leg. I looked down and it was Val. "I hate to interrupt while you're working, Harry," she said, "but the low charge alarm on Walter's electric is beeping." She looked at Alice Blue. "Harry, are you going to introduce us?"

I bent over, picked up Val, and held her in my arms. "Alice, this is my wife, Valerie Jaggers. Val, this is Miss Alice Blue."

"Pleased to meet you, Alice."

Alice walked over and stopped before me, her hand out to pet Val. "Is it all right?" she asked.

"Of course, dear," said Val as she climbed out of my arms and into Alice's. It frightened me, but I knew why Val did it. She was protecting me, and it's harder to kill someone while holding a big, warm, purring bundle of fur. As Alice

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stroked Val's back, my wife said quietly, "I couldn't help hearing what you were saying, Alice. May I offer a bit of advice?"

Alice nodded, her gaze fixed on Val.

"Doing the right thing is often a difficult choice to make. Even more difficult is accepting help when it's offered. Choices have consequences and not choosing is also making a choice. There are a lot of things to be made right, Alice, but there is also a great deal of help available. Harry, Guy, and Walter can assist you in getting that help."

Alice Blue looked down and Nadine was rubbing against her leg. She bent over, picked up Nadine, held both of them in her arms, and looked at me. "My first choice," she said.

"Actually, miss," said Walter, "you've already made several choices. We're all, after all, still alive."

She held the cats for a long time looking at a point somewhere outside the shack. She looked at Walter and said, "I've never been lost before. I think I am now. I'll take your therapist's number."

"Very good, miss."

To Shad she said, "In my opinion John Quinn is insane. He talks about you almost as though you were a constant presence. I gather he tried killing you before."

"Yes."

"It's twisted his head."

"How did he get the explosives into the country?" I asked.

"They were already here," she answered. "Quinn is on the board of World Eco Watch. A little satellite time using a high-definition metal detection filter on an artillery range and Quinn managed to locate what he wanted inside your jurisdiction. All he needed was a remote sonic detonator and a rat suit. He built the first and rented the second."

My own eyebrows went up. I had been wrong and everyone else had been right: It had been an old dud artillery shell. While I was contemplating the number of persons to whom I owed amends, Alice said, "Okay, Inspector. Tell me what you want me to do."

Walter drove, I sat in the passenger seat, Shad hovered between us, and Alice Blue sat in back with Val and Nadine as Walter headed for a service station in Okehampton. As we rode the track past the army camp, Alice told us how she was used to kill Guy Shad. She was only one of a variety of differently configured "torps" owned by a New York firm of political consultants whose front name was We Can Fix It. Of the many things We Can Fix It purported to clean up were the backgrounds of candidates for corporate and political office. John Quinn wanted to be governor of New York, using that office to step on up to the presidency. To do that he had to have a clean background: no childhood experimentation with controlled substances, no youthful indiscretions of a sexual or criminal nature, no undocumented maids on the payroll, and especially no years on the police force taking his cut from those who had their own opinions about which laws could be ignored—at least no one left who could remember any of it. As it happened, Shad's continued existence seemed to stalk Quinn like a specter, always there, always threatening to expose him. In Quinn's mind it had grown into something unreal and malignant. "He wanted to kill you himself—call you a rat to your face. He told me he had to," said Alice. "Always unfortunate when amateurs want to make of a killing more than it is."

"Hear, hear," said Walter. I glared at him, and he gestured a sort of apology.

"Two of John Quinn's associates are former detectives who are convinced Guy Shad could land them in the kind of trouble that runs politically uphill." Alice Blue smiled wryly. "What they don't know is that Quinn has We Can Fix It cleansing his two associates as well. Unfortunate fishing trip in Colorado in three weeks. I fear they'll get lost and die of exposure."

I looked back at her. "The New York

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authorities will need all that information as soon as possible."

The knowledge of an incoming call came into my head. It was Matheson. *"Jaggers, old boy! Near a telly?"*

I glanced at Walter. He nodded, touched a button on his steering column, and a screen dropped down from the roof. All those in the rear could easily see it, and Shad moved his mech back there for the improved view. By straining, I could see the screen from the side: constabulary police cruisers, light arrays flashing, in front of a small cottage. Matheson began telling me a channel number, but I interrupted and said we already had it and ended the call. The reporter doing the voiceover let us know that she was in Gidleigh, at great personal risk to her own person, as multiple police agencies descended upon the cottage's occupant suspected of being the Mad Moor Murderer. A disclaimer came up on the screen explaining that the bombing had taken place in northern Dartmoor, the use of the designation 'Moor' was for alliterative purposes and in no way referred to Moors, nor anyone of Moorish descent, nor does the term 'Mad' refer to mentally impaired, anger-management challenged . . . etcetera, etcetera.

"Matheson's making the bust in front of the TV cameras while we're out here in the boonies," said Shad. "By the time Walter's car is charged and we can make it to Gidleigh, it'll all be over. Matheson'll probably get a medal."

"The Wookie never got a medal," said Alice Blue from in back.

I turned and looked at her, not certain if she was joking. "That's true," I chimed in. "The Wookie did everything Han Solo and Luke Skywalker did. They got medals and the Wookie didn't."

"A clear case of human racism," added Val.

We all looked at Shad.

Shad's mech was silent for a moment. "Yeah," he said in good humor. "He did the same except for lines. The Wookie only had that one word to learn for his part." He then gave the Wookie call.

"That shouldn't have kept the Wookie from getting a medal," said Alice with a demure smile. "Patty Duke only said one word in *The Miracle Worker* and she got an Oscar."

"What word was that, sergeant?" Walter asked Shad.

"'Wawa,'" quoth the micro, granting the point. The motion passed unanimously. Resolved: The Wookie was stiffed, as we would be whenever it came time to pass out public kudos for taking down the Mad Moor Murderer.

After charging Walter's MG, we took the A 30 back toward Exeter to bring Alice Blue to Heavitree Tower for the first of many interrogations. Eventually the conversation turned to Shad's new meat suit. He said he was going to arrange with North American Biotronics for a replacement duck, which should be ready in a matter of weeks.

Until then, what? Walter wanted to know.

Shad said he was going to go to Celebrity Look-alikes of Bond Street, London, and pick something inspiring to wear until his new duck arrived.

Everyone else in the car entertained themselves speculating on which celebrity suit Shad would choose. Shad's big hero from his acting days was Lawrence Olivier, which was Val's choice. Nadine chose Sylvester the Cat, but I think she was joking. Walter thought actor Stephen Fry would be an excellent choice. Alice Blue, after much encouragement from Val and Nadine, smiled and chose Tick Tock from the Oz stories. All good selections and all quite wrong, I feared.

I had been with Guy Shad long enough to know how his mind worked. I began bracing myself to refuse to react even a little bit when he appeared for duty as Nigel Bruce playing Dr. Watson. ■

(EDITOR'S NOTE: Jaggers and Shad appeared earlier in "The Good Kill," November 2006.)

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THE REFERENCE LIBRARY Tom Easton

The Last Colony, John Scalzi, Tor, $23.95, 320 pp. (ISBN: 0-765-31697-8).

Sixty Days and Counting, Kim Stanley Robinson, Bantam, $25.00, 391 pp. (ISBN: 978-0-553-80313-6).

Ragamuffin, Tobias S. Buckell, Tor, $24.95, 317 pp. (ISBN: 0-765-31507-6).

Brasyl, Ian McDonald, Pyr, $25.00, 358 pp. (ISBN: 978-1-59102-543-6).

The Quest for the Trilogy: A Rover Novel of Three Adventures, Mel Odom, Tor, $25.95, 462 pp. (ISBN: 0-765-31517-3).

The Mathematics of Magic: The Enchanter Stories of de Camp and Pratt, L. Sprague de Camp and Fletcher Pratt, Mark L. Olson, ed., NESFA Press, $26.00, 512 pp. (ISBN: 1-886778-65-5).

The Involuntary Human, David Gerrold, NESFA Press, $27.00, 480 pp. (ISBN: 1-886778-68-X).

Brave New Words: The Oxford Dictionary of Science Fiction, Jeff Prucher, Oxford University Press, $29.95, 342 + xxxii pp. (ISBN: 978-0-19-530567-8).

John Scalzi concludes the series he began in *Old Man's War* with **The Last Colony.** The original premise was a nice inversion of traditional modes of warfare and a lovely echo of a line I first heard in the '60s, when critics of the Viet Nam war would say that it was so typical, old men sending young men off to fight the old men's war, and wouldn't wars be a lot simpler and shorter and even less likely if we could send the old pharts off to fight their own battles.

Maybe, but it wasn't very likely, then or now. So Scalzi imagined a future when humanity goes to space and discovers we're not the first. There are plenty of folks already out there, they're constantly fighting over colony worlds, and not one of them appreciates a new kid on the block. Hence the Colonial Defense Force, a need for troops, and at least a perceived need to keep the folks back home in the dark about how dicey things really are. So the CDF makes Earth an offer: Once Earthlings pass age 75, they qualify to join the Colonial Defense Force and be given a nice new super-strong young body with which to stave off the hordes of ravening aliens who threaten the colonies. The first novel started with John Perry and his wife Kathy. Alas, Kathy died too soon, but those who volunteered and died before their transformation got their DNA used to produce even superer soldiers for *The Ghost Brigades.* In due time, John became a hero and met Jane, who looked just like Kathy, presumably because she was Kathy's "ghost." Together they went off in pursuit of a traitor scientist, Charles Boutin, who was trying to help the aliens defeat humanity, in part by tinkering up an electronic gadget that would give the definitely sentient Obin true consciousness. John and Jane wound up adopting Boutin's daughter Zoe, who came with two bodyguards from the eternally grateful Obin.

Last Colony opens to show John and

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Jane on the colony world of Huckleberry, where he is an ombudsman with a Solomonic gift for conflict resolution. Then the CDF's General Rybicki shows up to announce that they have a new assignment, managing a new colony called Roanoke being set up in defiance of an alien ban on new colonies. In other words, they're being planted right in the middle of a big red bull's-eye, all so the CDF can try to weaken the alien Conclave that forbade new colonies. Not that Rybicki is very forthcoming with this. The CDF is big on the mushroom theory of governance (keep 'em in the dark and feed 'em horse manure), so all John and Jane know at first is that Roanoke is supposed to be the very first colony settled from the colony worlds instead of Earth, they've got Mennonites aboard, and the manifest includes a lot of really retro gear. It's up to John and Jane—somehow!—to keep Roanoke from being pounded into dust. Where the earlier novels were pretty pure space opera, this one's all politics, of course, with much of it sounding fairly familiar. Zoe and the Obin turn out to be very helpful, and the CDF winds up with plenty of egg on its face as well as having to face some major changes in the way it does business, rooted largely in what John does to the mushroom farm.

As usual, I'm trying not to give away too much, though I can't help giving you a few cryptic clues. But no more. Scalzi has already shown himself to be a capable, dependable writer. If you've enjoyed the earlier books in this series, you know you just have to get this one. And if you picked up *The Android's Dream* (reviewed here last March), you know he has more stories to tell, just as entertainingly. Watch for them!

This one is space opera that looks fruitfully at the classic nature-nurture problem and concludes that one's experiences can make all the difference in the world. Scalzi once more does a very nice job.

* * *

Sixty Days and Counting concludes Kim Stanley Robinson's eco-trilogy (preceded by *Forty Signs of Rain* and *Fifty Degrees Below*). Bantam bills them all as thrillers, but this one is more of a political diary, and as such I found it quite interesting. But thrilling? Not really.

Robinson's theme is the potential impacts of global warming, which—paradoxically!—include regional freezing. Indeed, in the last novel the Gulf Stream, which carries warmth from the tropics to the North Atlantic and thereby keeps England (which is on the same latitude as Labrador) habitable shut down and had to be restarted by massive human intervention. *Sixty Days* begins later on, when Phil Chase has become the president-elect and Frank Vanderwal, Charlie Quibler, and others are frantically looking for solutions to widespread droughts and extinctions. The search is complicated by Frank's brain injury and the absence of Caroline, who is being pursued by a black-ops agency starring her ex. But the complications are pretty low-key; even the attempted assassination of the president is more pro forma than anything else. Front and center is a U.S. president who has dedicated his first sixty days to redirecting policy, the economy, industry, energy, and more in the direction of sustainability, meaning less carbon, less greed, and more social justice. And it all moves ahead without nearly the obstacles one might expect.

So it's a political diary. New policies, aimed at mobilizing new technologies (most of which have been known for years), reining in corporate rapacity, and redirecting human motivation. It amounts to an agenda for change, so it's also a bit of a tract.

As a tract, how on target is it? I write textbooks in the field, so I can say that it seems very likely that the day will come—not tomorrow, but within a depressingly small number of decades (perhaps even before I die, and I'm 63)—when we will need to make

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changes just as drastic as Robinson portrays here. The details will surely be different, but most of the technologies he mentions as useful are either well-known (if not well-funded) or very short horizon. One, limiting sea-level rise by pumping seawater onto the Antarctic ice cap and into low spots on continents (though he fails to mention the extensive Qattara and Fayum depressions in North Africa; there have been proposals to dig canals from the Mediterranean and use the flow to generate power), is strikingly grandiose but perhaps feasible. The policy changes he puts in the story, of which the most important may be finding ways to stimulate the use of capital to help solve (instead of worsen) the problem, seem essential.

Does it work as a novel? It has plot and characters, but not much excitement. The dominant element is message, and a great many readers don't care for that. If you're a Robinson fan, though, it may not bother you a bit.

If you read Tobias Buckell's *Crystal Rain*, you surely wished to know more about the universe outside Nanagada. He hinted then, but all he said was that when Earth reached for the stars, it found folks already there. The ensuing debacle sent human refugees hunting desperately for worlds without aliens. One group—a mixed bag of Caribbeans, Aztec wannabes, French-speakers, and others—succeeded. But hot on their heels came the Teotl, who promptly assumed the role of Aztec gods and set things up for war and sacrifice. In **Ragamuffin**, Buckell reveals a great deal more. This sequel opens at the Pitt's Cross reservation on Astragalai, where Nashara is finally leaving, escaping a ghetto trap to resume her mission on behalf of Chimson, a world that, like Nanagada, has long been cut off from the stars.

A reservation? That's right. Under the alien dominated Benevolent Satrapy, humans live in reservations or ghettoes. Some are free, working as Hongguo, mercenaries, for the satraps and telling themselves they keep humanity alive by squashing defiance. Some exist as pampered pets. You can guess what Nashara's mission must be, but before she can do anything about it she must get as close as she can to New Anegada (Nanagada, of course). Hunting for a suitable stop, she soon discovers she is hunted. Worse than that, the Hongguo are now exterminating human habitats. Humanity seems doomed.

Meanwhile, back on Nanagada, the wormhole is reopening and more Teotl are coming through. But they too, it turns out, are refugees fleeing the Satrapy. Is alliance possible? Will they—and John deBrun and Pepper, the still-living representatives of the humans who first fought the Teotl centuries ago and are now renewing the battle—hook up with Nashara? Is there hope?

Science fiction being what it is, of course there is. Nashara is a powerful secret weapon who needs only to be able to link to the Hongguo computers to stop them in their tracks (unless they have borrowed a leaf from Sean McMullen's notebook and built computers from brain-controlled human beings). There is a human resistance movement ready to kick into high gear. The Teotl, despite being reduced to a remnant of former glory, have some very interesting technology. Some of the Hongguo are rather less under the Satrapy's thumb than anyone suspects. And the free humans are royally pissed-off, which as all SF readers know is all it really takes.

Is that a touch snarky? Well, maybe. "Underdog wins" is a popular theme in the genre, and it never seems to matter how massively outgunned the underdog is. Buckell breaks no new ground here, but he does do a very satisfying job of constructing his setting and characters. The plot moves rapidly and smoothly, and the reader should enjoy the ride.

Have fun!

* * *

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Ian McDonald tries to repeat his *River of Gods* success with **Brasyl**, with some panache. The setting is Brazil, Rio, the home of Carnival and samba, which is enough to lead the reader to expect flamboyance and verve. In the same spirit, Brazil is also a realm of vast economic contrasts, where the poor throng the favelas, "bairro" makes us think of "barrio" but means only "city district," the rich buy their daughters nose jobs for high school graduation presents, and local TV makes North American tabloid TV look prim. That last is where it starts, with Marcelina Hoffman, TV producer on the make, worshipper of Our Lady of Production Values, supervising an entrapment show: leave a hot car on the street, and follow it, cameras rolling, when it gets stolen. Her life gets complicated when she starts running into signs that she has a double who steals her cab and sends messages under her name. Then there's Edson, a young man of the favelas, just as on the make as Marcelina. He has multiple identities to evade the ever-present surveillance, and through him we run into Fia Kishida, quantum physicist with a rack of bootleg quantum cores, and the Q-blades, quantum devices that slice through everything. His life gets complicated when goons with Q-blades destroy Fia (at least until he runs into *her* double, and then complicated ain't the word for it!).

McDonald soaks us in atmosphere: flamboyance, verve, religions (including soccer), lunch-hour plastic surgery, and all the rest of the potpourri that defines modern Brazil. Then he pops back to the 1700s, when an Irish Jesuit, Luis Quinn, is arriving to bring an errant missionary back to the fold. More atmosphere, darker, tinged in the blood and suffering of enslaved natives, and an expedition up the Amazon and its tributaries to find the missionary, building a City of God, but also enslaving and slaughtering. His life gets complicated when he is sent off to visit a tribe of natives with a reputation for accurate prophecy. It turns out that they capture emissaries such as Quinn, force them to drink the juice boiled out of a certain frog, which makes them see visions of multiple realities. Once they have answered questions, they generally die. But Quinn survives, maintains the ability to see the multiverse, and . . .

Quantum physics. Parallel worlds. Now you know where the doubles come from, but you don't have any idea what's going on. For that you need to add Tipler to Wheeler and think of Omega. There's a war on, and it's much more concerned with image than with anything real. That makes Brazil the perfect stage for this play, even as it calls into question the nature of reality and free will.

Brasyl is an impressively energetic novel that gains a great deal from the exotic ambience of its setting. It also makes an interesting philosophical point at the end: Only in imperfection, perhaps the work of the devil, can we find hope.

McDonald is well worth your attention.

The halflings are halfers (or dwellers), and they don't dwell in holes, but they have hairy feet and they're stubby little fellows. The goblins are goblinkin, the wizard looks a lot like Gandalf, there's a dread lord in the background, and the dwarves wield mean battle-axes. And if there isn't a ring to dispose of, at least there's a quest. What more do you want? Well, maybe a little intelligence of the sort that is sadly lacking when Mel Odom tells the reader with a straight face that paddocks are found inside livery stables (p. 193).

If you don't mind blatant, ham-handed derivatives of classic works of fantasy, get a copy of **The Quest for the Trilogy: A Rover Novel of Three Adventures.** The basic notion is that Grandmagister Librarian Juhg, heir to the leadership of the Vault of All Known Knowledge and a halfer to boot, is trying to persuade hu-

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mans, elves, and dwarves to establish schools, learn to read, and unify the realms before the goblinkin return. Wizard Craugh interrupts the proceedings by hauling Juhg off on an adventure, beginning by warning him of Kharrion's Wrath, a disastrous implement left behind after the Dread Lord Kharrion was defeated an age ago, and handing him a book penned by his predecessor, the famed Rover and Grandmagister Lamplighter Wick. The book is written in a code that only Juhg knows, and soon the reader is following Wick's search for the lost battle-axe of Oskar the dwarf smith (also at Craugh's behest). The book ends with a clue to the location of volume two, and thence to volume three. Meanwhile bog beasts invade a tavern, Craugh vanishes, leaving the word "Beware!" scrawled beside a puddle of blood, an animated scarecrow warns Juhg off the search, and . . .

You get the idea. It's adventure designed to appeal to fans who crave more of the same old same old, but not those who want a bit of originality or care with details. Not recommended.

L. Sprague de Camp was one of the greats of SF&F. Anyone who ever reads his tales remembers them and revisits them happily for many years. Among his most memorable were the "Enchanter" tales he penned with Fletcher Pratt, beginning in 1940. Some of them were collected in *The Incomplete Enchanter* (1941), more in *The Compleat Enchanter* (1975) and *The Complete Compleat Enchanter* (1989). Now NESFA Press puts everything together in a single package, complete with a reminiscence by de Camp and an essay on how the hero should have been equipped by Jerry Pournelle, as **The Mathematics of Magic: The Enchanter Stories of de Camp and Pratt.**

The basic idea is that logic—a syllogismobile—can flip a character out of our familiar world into one of myth. To keep it entertaining, the hero, Harold Shea, tends to aim for one target and hit another, so he winds up visiting and adventuring in the worlds of Norse, Finnish, and Hindu myth, *The Faerie Queen*, and even Barsoom. It's all grand fun in the old *Unknown* mode, which insisted that fantasy could be as logically constructed as SF (Heinlein had a go at it too, with *Magic, Inc.*).

It ain't new, but it's still a treat. So treat yourself!

David Gerrold has been one of my favorites since well before he and I and David Brin went to Miami to help the local PBS station think about doing an environmental SF show. It's still a good idea, even though they never did it. David G. is a good idea too, and I have long thought it a shame that we live on opposite coasts. But then the folks at Boskone got the bright idea to make him their 2007 guest of honor, so I got a chance to set and chat a bit with him, as well as to tell you about the Boskone GoH commemorative book, **The Involuntary Human.**

The introduction is by Spider Robinson, in which (he says) he tells the truth for a change, but David felt the need to issue a rebuttal. Since both of them are fond of puns, you can imagine the flavor. And that's before David gets down to business with a collection of Heinleinesque aphorisms by Solomon Short, followed quickly by one of his best-known tales, "The Martian Child." A bit later, after more Short stuff, he gives us "Blood and Fire," an unproduced *Star Trek: The Next Generation* script, written in 1986, and carefully refrains from telling the true story about what happened (though he does say that whatever you may have heard elsewhere is not the Truth at all). Add in an excerpt from the sixth Chtorr book, some Satanic limericks (cars illegally parked by the witches' school will be toad—I *said* he liked puns), and . . .

There's more, of course, short (and Short) and long, fiction and non, loads

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of pages of very good stuff.

Enjoy!

Jeff Prucher has assembled the very first dictionary that focuses on the terminology of SF, SF criticism, and fandom. It's **Brave New Words: The Oxford Dictionary of Science Fiction,** and while it's hardly exhaustive—as he says, practically every story in the genre introduces a new term or a new usage, so he focused on some 3,000 terms that have been used by many authors, often in many ways—it is an illuminating look at the history of the field. Perhaps most illuminating is that as you leaf through it, you find many terms first coined in SF (robot and stun gun, for instance) that are now part of the broader language. The shift has to do with the way science and technology eventually make SFnal dreams come true, as well as with the way SF penetrates the culture via film and TV. And most folks have no idea of where the terms came from! ■

IN TIMES TO COME

Barry B. Longyear's unique detective team of Jaggers and Shad is back next month in the novella "Murder in Parliament Street," which among other things, features probably the most unusual air force you've ever encountered—plus, of course, a mystery with a twist. We'll also have quite an assortment of other stories by writers including Henry G. Stratmann, John G. Hemry, Carl Frederick, David Walton, and Bud Sparhawk.

Richard A. Lovett's fact article ventures into unusual but intriguing territory: "The Search for the World's First Equestrians." Who were they, how did they get that way, and how do we know? It's a fascinating look at both an often-overlooked wellspring of technology, and some of the less glamorous aspects of archeology.

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BRASS TACKS

Dear Stan,

In the June 2007 issue of *Analog,* which I recently scanned in the Pasadena library, I found an editorial on the subject of material suitable for publication in *Analog.* In particular I noted the requirement in general that stories for *Analog* conform to scientific principles and laws. Even whimsy should refer to assumed natural law such as the use of Hell as a heat source in reference to the second law of thermodynamics.

I find this intriguing because in recent years the establishment view of physical theory has been increasingly challenged. The rise of cold fusion, Mill's hydrinos, and various claims to vacuum tapping electromagnetic and permanent magnet generators are a challenge to the mainstream view.

Perhaps the most open and defiant challenge to the prevailing view of these matters can be found in the Steorn challenge to the scientific community. Theoretical arguments in most of these cases are offered which are contrary to current mainstream theory. Indeed, Thomas Bearden's modifications of electromagnetic theory would offer scope to most forms of fantasy. I am assuming that you are familiar with this because Jeffery Kooistra publishes in your magazine and he was once associated with Eugene Mallove and *Infinite Energy* magazine, perhaps the greatest of all critics of the prevailing view of scientific theory.

Aether theory is making a new bid, quantum mechanics is challenged by Randell Mill's reinterpretation of the theory, and claims of successful unification of gravitation and electromagnitism are appearing on the internet (See Myron Evans). Many of the proponents have decent to very good academic credentials to lend credibility to their claims. However, mainstream science publications such as *Nature* and *Science* dismiss such claims as fraud or nonsense and little is heard of these matters in the mainstream press.

Still, this issue is being raised by these claims. What is science and who speaks for it? Is scientific theory whatever the actual nature of the material world is, or just an ideology? Scientific opinion is revised over time, often with much acrimony, but what happens if the scientific enterprise devolves into multiple schools of thought and it is no longer possible to speak of a single point of view on any particular topic? And as these schools cannot all be right, credibility wanes. In the end science and hence science fiction may appear to be more fiction representing an ideology as would Catholic fiction, Protestant fiction, Communist fiction, or Capitalist fiction.

Such an argument would suggest that the only real difference between science fiction and fantasy is orthodoxy. Science fiction is fiction based on the current accepted view of reality and fantasy is not. But science may not just change its opinion, it may also simply disintegrate into competing voices and orthodoxy is lost. In that case what is the real distinction

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between a science fiction story and a fantasy story when confidence that the science is real is lost? No one can really know the future of scientific opinion or even if it will remain single. Thus it would seem that the distinction between science fiction and fantasy is mere prejudice. An assertion that the current accepted view of reality will prevail in the future. The distinction between a science fiction magazine such as *Analog* and a fantasy magazine is no more than appearance.

I would like to suggest that you should comment on these matters in some future editorial. The prevailing view of science keeps alive the tokamak fusion program, denies scope to Robert Bussard's focused fusion reactor, not to mention many potentially more effective power sources, assures no solution to global warming (if it is itself not just an intellectual fraud) than to suffer energy poverty and assures that the settlement of the solar system will be painful, difficult, and slow if it is ever attempted. All of the future that *Analog* has in its history promoted is in danger from a worldview buttressed by prevailing scientific orthodoxy. It would be much better if *Analog* would entertain stories based on other scientific premises. There may not be that much to lose and much to gain in bringing to the public a wider point of view.

James Wood

Actually, I have commented on these matters in many previous editorials, and Analog *stories have always featured both "real" and alternative science. The difference between science fiction and fantasy is* not *just orthodoxy! But science is based on accumulated evidence and logically constructed models to explain and extrapolate it. It's very important for some science fiction to explore new models—but they have to be constructed with the same regard for logical consistency and agreement with observation as older models. In other words, it's wonderful if you can write convincingly about things that sound impossible—but if you want our audience to swallow them, you have to provide some basis (not necessarily today's orthodox science) for regarding them as plausible.*

Dear Stan,

Thank you very much for defining the limits of what *Analog* will accept. I'm just a reader, not a writer, and I read *Analog* because I know what I like. For example, I will always pass over any anthology edited by a certain very (perhaps most) famous editor of anthologies, because his tastes and mine differ greatly.

But your acceptance criteria are broad enough to include the occasional (and rare) story I don't care for, and also the occasional story that is in the boundary area that I really love. An excellent tradeoff in my humble opinion.

As for your comments about the Star Wars series, I prefer to believe my cousin's advice, when I had mentioned to him back in 1977 or so that I had no intention in seeing an obvious fantasy movie. To which he responded, "Trust me, put your mind in neutral, and go see it if only for the 'sleazy spaceport bar' we've all read about in the older pulps." Certainly it was good advice. Which is why I'm glad your boundaries are a bit wider than a strict interpretation of "science fiction" would normally dictate.

Again, and still, thanks for the premier magazine in the field.

Don Manyette

Dear Dr. Schmidt:

I'm writing because I have some concern for where science fiction is going these days. In my mind at least, it has been backing itself into a corner for some time now, in a way that is so introverted and stylized that only the hardcore dedicated reader can enjoy it.

If you've not already seen it, I would

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direct your attention to a recent article in "Wired":

<http://www.wired.com/culture/culturereviews/news/2007/04/scifighetto_0412>

I have to say I can understand the sentiments expressed there. I started reading science fiction in the early '50s, a joy to me because it offered a different view of humanity, unrestricted by the conventions of the present, and buoyed by new understandings of science, in particular, astronomy. It was why I became a scientist (See the book about me on Amazon.com). Granted, the stories of those times were weak in character development, but that didn't seem to matter because so many new possibilities were being explored that had never appeared in print before.

But, sad to say, all that has all changed. The early writers could write about galactic civilizations and intrepid time travelers, but all that has been done to death now. What should a science fiction writer do now? Cutting-edge science is now about working out the details of how the universe in constructed and esoteric theories of how the universe was formed. We now *have* space travel, and some major scientists are seriously considering how to build a time machine. What is left that can be legitimately called science fiction that is fresh and new? Has science fiction reached the end of its run?

I hope not, because I think its approach can still offer a fresh look at humanity. But, in my humble opinion, things have to change. For science fiction to remain viable, it has to focus on what it was really about all along—not science per se, but about its effect on people.

But, strange to say, as the article above points out, that particular aspect of science fiction is only considered appropriate in non-science fiction works. And that is the state of science fiction today. Science fiction has been shunted off to quirky, convoluted tales that primarily value the coveted banner of science fiction today, the idea of the original science-based idea.

And that is the problem. Science fiction is being killed by its unwillingness to abandon its original goal of exposing new scientific ideas to the public. I understand that to become merely stories about real people living in a future where science has a major impact on their lives is not much different than exactly what we have now in the 21st century. This is the future the early science fiction writers wrote about. Unless you're living in a hole somewhere, you understand science has a major impact on your life, and you understand there are serious consequences implied by that knowledge, ranging from the current decrease in the Earth's magnetic field to the certain probability of all life being wiped out by an asteroid impact sometime in the future.

So if traditional literature has taken up the mantle formerly held by science fiction, where is science fiction to go? That is the question, and in my opinion, it needs a good answer soon before it disappears as a viable art form altogether.

Henry M. Harris
Pasadena, CA

You're certainly right that it's harder than it once was to come up with new, viable ideas that still feel speculative, but it's hardly impossible. Does anybody really believe that the early 21st century is not much different from all the millennia stretching ahead? Writers may have to reach farther now, but remember that what writers were doing forty or fifty years ago, much of which we now take for granted, was quite a stretch back then.

And the effects of science and technology have long been our major emphasis—but we still prefer to look at the effects of new *science and technology, rather than just the lives of people in the world as it has already changed.* ■

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UPCOMING EVENTS Anthony Lewis

13–15 July 2007
THINK GALACTICON (Political SF conference) at Roosevelt University, Chicago, IL. Guests: Nalo Hopkinson, Nisi Shawl, Nnedi Okorafor-Mbachu. Registration: $35 until 28 May 2007, $40 thereafter; supporting memberships: $15. Info: thinkgalactic.org; info@thinkgalactic.org.

27–29 July 2007
M.O.O.N Con-Middle of Outer Nowhere Con (Wisconsin SF conference) at Ramada Inn/White House Conference Center, Richland Center, WI. Registration: $30 until 29 June 2007, $35 thereafter. Info: www.mooncon.bravehost.com; m_o_o_n_con1@yahoo.com; Robert Poole 1-877-225-5928 (toll-free, Robert Poole).

30 August–3 September 2007
NIPPON 2007 (65th World Science Fiction Convention) at Pacifico Yokohama, Yokohama, Japan. Guests of Honor: Sakyo Komatsu and David Brin; Artist Guests of Honor: Yoshitaka Amano and Michael Whelan; Fan Guest of Honor: Takumi Shibano. Registration: USD 220; JPY 26,000; GBP 125; EUR 186 until 30 June 2007; supporting membership USD 50; JPY 6,000; GBP 28; EUR 45. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. This is only the third time Worldcon will be held in a non-English speaking country and the first time in Asia. Info: www.nippon2007.org; info@nippon2007.us. Nippon 2007/JASFIC, 4-20-5-604, Mure, Mitaka, Tokyo 181-0002. North American agent: Peggy Rae Sapienza, Nippon 2007, PO Box 314, Annapolis Junction, MD 20701, USA. UK agent: Mike Rennie, 68 Crichton Avenue, Burton Stone Lane, York, Great Britain YO30 6EE (sparks@lspace.org). European agent: Vincent Doherty, Koninginnegracht 75a, 2514A Den Haag, Netherlands (VJ1709@hotmail.com). Australian agent: Craig Macbride, Box 274, World Trade Centre, Victoria, 8005 Australia (nippon07@f8d.com).

1–4 November 2007
WORLD FANTASY CONVENTION at Saratoga City Center and Saratoga Hotel & Conference Center, Saratoga Springs, NY. Guests of Honor: Carol Emshwiller, Kim Newman, Lisa Tuttle; Special Guests of Honor: Barbara & Christopher Roden, George Scithers; MC: Guy Gavriel Kay. Registration $135 until 31 March 2007, $35 supporting. Info: http://www.lastsfa.org/wfc2007/; World Fantasy 2007, Post Office Box 1086, Schenectady, NY 12301.

Attending a convention? When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an International Reply Coupon if the convention is in a different country. ■

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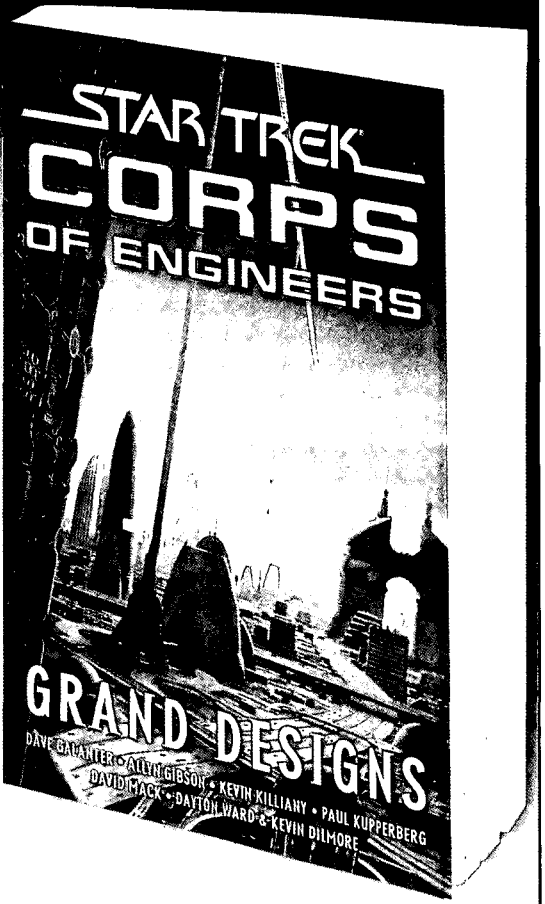
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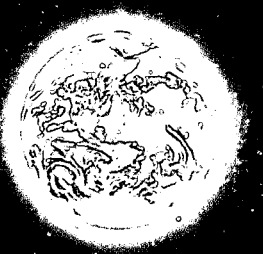

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